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THE MAMMALS OF INDIANA.

A Descriptive Catalogue of the Mammals Occurring in Indiana in Recent Times.

BY

WALTER LOUIS HAHN, Ph D

LETTER OF TRANSMITTAL.

SPRINGFIELD, SOUTH DAKOTA, February 5, 1909.

Hon. W. S. Blatchley, State Geologist, Indianapolis, Indiana:

Dear Sir—I herewith transmit for publication by your department a report on the Mammals of Indiana. The preparation of this report was begun almost five years ago while the writer was employed as aid in charge of the Division of Mammals in the United States National Museum at Washington. During the past two years the work has been continued, at such times as opportunity offered, with your co-operation and under your direction. Field work was carried on for a short time in 1904, 1905 and 1906, with the co-operation of the National Museum; in 1906 and 1907 with the co-operation of Indiana University, and in 1907 and 1908 with aid from your department. While the collections made are by no means exhaustive, it is believed that nearly all of the species occuring in the State have become known, either through specimens or authentic records.

Respectfully yours,

WALTER L. HAHN.

INTRODUCTORY REMARKS.

Considering the size, abundance and economic importance of the group, probably no branch of natural history has been so much neglected in Indiana as the study of mammals. In seeking information in any locality it is usually necessary first to explain what is meant by "mammal." Then the resident, whether he be farmer, hunter or amateur naturalist, is usually unable to enumerate more than six or eight kinds of fur-bearing and game animals.

If asked concerning shrews, it is probable that he will say very positively that there are none. Possibly he may admit the existence of some kind of mouse other than the house mouse, but on being shown specimens of meadow mice he will call them moles, and when the collector brings in shrews, trapped perhaps within sight of his house, he will either say that he has never before seen such animals or assert that they are young moles, and he is usually astonished if a collector secures twenty or more species of small mammals in his locality in a week or ten days.

The professional naturalist is but little better informed concerning the mammals of this region. The Central States have been passed over for more fruitful fields by the government agents and museum collectors. When the writer began gathering material for this paper five years ago, there were not a dozen Indiana specimens in the national collections at Washington. The State Museum at Indianapolis contains a fairly representative mounted collection, but lacks a number of species of mice, shrews and bats, and has no reserve material for study. With the exception of Indiana University, where there is a small collection, there are no specimens available in any Indiana college.

The primary purpose of this paper is to furnish a contribution to the zoology of the State which will enable students to identify the species of Indiana mammals, and which will give the principal facts known regarding their distribution, life history, habits, food and relation to man.

MATERIAL AND ACKNOWLEDGMENTS.

Work on this article was begin in 1904 while the writer was employed in the United States National Museum at Washington, as an aid in charge of the Division of Mammals, and much of the

preliminary work was done in that institution. The National Museum also afforded an opportunity to spend a month in field work in the Kankakee Valley during the summer of 1905. The Field Museum of Chicago and the collections of the Cincinnati Society of Natural History each contains a few specimens of mammals from Indiana, and the writer is indebted to the authorities of these institutions for the privilege of examining them.

Since 1904 the writer has spent a short time each summer in collecting at his home in Ohio County. A part of the specimens obtained there have been sent to the National Museum and others are retained in the private collection of the author.

During two years the author held a fellowship in zoology in Indiana University, residing one year at Bloomington and one year on University Farm at Mitchell. Considerable time was spent in collecting and studying mammals at both places, the University furnishing the necessary equipment, and this article is No. 100 of the contributions from the zoological laboratory of that institution.

Finally, the Indiana Department of Geology and Natural Resources has made possible two short collecting trips, one to the lake region of the northeastern part of the State and the other to the cypress swamps of the Wabash Valley.

No one realizes more fully than the writer that the material thus brought together is not adequate for all purposes. It is believed that all the species occurring in the State have been collected, with the exception of a few that are not at all common, and only the most intensive collecting in all parts of the State, or fortunate accident, can discover them. But the central part of the State has scarcely been touched, and it is not possible to give, with even approximate definiteness, the limits of the subspecies which intergrade in this region. The limits of some other species which do not have a range including all of the State are also but poorly defined. Discussions of geographic distribution must therefore be limited, but it is hoped that the accounts of the habits will partly make up for this deficiency.

The writer has not hesitated to use information from every available source. The preliminary list and bibliography of Indiana mammals published by Evermann and Butler in the Proceedings of the Indiana Academy of Science for 1893, and the additional notes of Butler in the same publication for 1894, have been an invaluable basis for the work. Of the general works, American Animals, by Stone and Cram; Merriam's Mammals of the Adiron-

dacks, and Rhoads' Mammals of Pennsylvania and New Jersey, have been relied on for much information. The numerous monographs published by the Department of Agriculture and the National Museum have also been invaluable, and most of the figures of skulls and teeth have been borrowed from them. The nomenclature is that of Miller and Rehn's List of North American Mammals, with a few corrections, made necessary by discoveries since its publication. The keys are modified from Miller's Key to the Land Mammals of Northeastern North America. A full list of the works consulted in the preparation of the paper will be found in the bibliography.

Much information has been received from men in all parts of the State whose names it is not possible to enumerate. But special thanks are due to Mr. E. J. Chansler, of Bicknell, for notes and information very carefully collected by him in that locality during many years; to Prof. Van Gorder for similar notes from Noble County; to Dr. C. H. Eigenmann, of Indiana University, for assistance in many ways, and to Prof. W. S. Blatchley for information and assistance, and for the assistance from his Department which has made possible two field trips.

THE CLASS MAMMALIA.

STRUCTURE AND ZOOLOGICAL POSITION.

The class *Mammalia* includes such diverse creatures as whales, bats and man, as well as most of the common four-footed animals. Unfortunately the word "mammal" has never come into general use, and there is no other word in the English language that is an exact equivalent. Quadruped, which is sometimes used, includes lizards, frogs and other animals which are not members of the class, and does not include whales, man and bats, which are.

A mammal has been very simply defined as a "warm blooded, air-breathing animal that suckles its young." In addition to these characters, land mammals are always covered with hair and never with scales; there is a complete double circulation of the blood and a four-chambered heart; the skull articulates with the vertebral column by means of two rounded surfaces (occipital condyles) instead of one, as in birds and reptiles; there are teeth in both jaws, except in a few species in which they have degenerated; there is a corpus callosum uniting the two hemispheres of the brain; a complete diaphram separates the thorax from the abdomen; and, most important of all, the fertilized ovum is retained in the body

of the female and the embryo is nourished from the blood of the mother to a late stage of development by means of a special structure (placenta), which is cast off at birth.*

It will be seen, therefore, that the mammals have the most highly specialized structure of all animals. In the development of the senses, in habits and in mental capacity they stand at the top of the animal kingdom.

In size they vary from a tiny shrew or bat weighing a fraction of an ounce, to the great blue whale, weighing sixty or more tons.

ECONOMIC IMPORTANCE.

A number of species have been domesticated by man and have been made to furnish him with food and clothing. The wide variation in the habits of mammals bring many of the wild species also into intimate relation with man. The members of the class have become adapted to surroundings in a variety of ways. Some live constantly in salt water; some are burrowing animals, spending their lives under ground; others are terrestrial and still others arboreal, while the bats are adapted to aerial locomotion. Their feeding habits are necessarily as varied as their means of locomotion, and some destroy crops or even endanger human life, while others are of great benefit on account of the noxious animals they destroy.

GEOGRAPHICAL DISTRIBUTION.

The distribution of any species of animal is determined by physical conditions. Of these, temperature is the most important. Very rarely do species have a north and south distribution extending through more than twenty or twenty-five degrees of latitude, and very few have a range as great as that. Their distribution is also influenced by humidity, drainage and elevation.

These factors are all relatively constant in Indiana, hence the mammalian fauna is much the same throughout the State.

A scheme for dividing the United States into faunal areas and zones has been proposed by Dr. Merriam† and generally accepted by other zoologists and botanists. According to his map, most of Indiana is in the Carolinian faunal area of the upper austral zone, with a small strip of the lower austral zone coming into the lower Wabash Valley.

* The placenta is entirely lacking in the Australian duck-bill and Echidna, and but imperfectly developed in the opossums and other marsupials.

† Life Zones and Crop Zones of the United States. Bull. 10, Div. Biol. Surv., U. S. Dept. Agr.

An examination of the mammalian fauna bears out Dr. Merriam's conclusions, although the lower austral species are not numerous. The species typical of the more southern latitudes are the southern shrew (*Sorex longirostris*), Carolinian short-tailed shrew (*Blarina brevicauda carolinensis*), long-eared bat (*Corynorhinus macrotis*), large-winged bat (*Myotis grisescens*), small shrew (*Blarina parva*), water hare (*Lepus aquaticus*), spotted skunk (*Spilogale putorius*), and water rat (*Oryzomys palustris*), the last being of questionable occurrence.

In the northwestern part of the State a few species that are characteristic of the western prairies, reach the eastern limit of their range. These are the two spermophiles (*Citellus tridecemlineatus* and *C. franklinii*), the pocket gopher (*Geomys bursarius*), coyote or prairie wolf (*Canis latrans*), prairie skunk (*Mephitis mesomelas avia*) and the badger (*Taxidea taxus*), the last being now almost extinct. The prairie mouse (*Peromyscus maniculatus bairdi*), prairie vole (*Microtus ochrogaster*), and prairie rabbit (*Sylvilagus floridanus mearnsi*) are also of prairie origin, although they now extend over nearly or quite all of the State.

Four species, the porcupine (*Erethizon dorsatus*), the fisher (*Mustela pennanti*), the wolverine (*Gulo luscus*) and the star-nosed mole (*Condylura cristata*) are believed to be of northern origin. The first three of these are also extinct.

It will thus be seen that the fauna of the State is not characteristic of any zone or faunal area, but that it is rather characterized as an area where the different faunal types blend. In the absence of mountains or other barriers, it is not possible to fix upon definite boundaries of the life zones.

RELATION TO ENVIRONMENT.

In their relation to the mammalian fauna, physical features other than climate, have a marked influence. The hilly southern portion of this State is better suited for many species of animals than the more level regions in the central and northern parts, and such animals as rabbits, opossums, weasels, minks and skunks are more abundant. Caves, which are numerous in some counties, afford homes for bats, and these animals are abundant in the cave regions. On the other hand, some mammals, especially two or three species of voles or meadow mice, are inhabitants of damp places and are most abundant among the lakes and swamps in the northern part of the State.

PLATE I.—A woodland habitat of the type common when the State was first settled, but now almost gone. University Farm, Mitchell, Indiana.

Classified on the basis of habitat, the sixty-six species of mammals recorded from Indiana may be roughly divided into four groups: (1) Those that live chiefly in the woods; (2) those that live chiefly in the grassy fields and prairies; (3) those with a general range including forest and field; (4) those whose habitat is not closely related with either grass or trees, but whose presence is due to some special reason.

The following 14 species belong to the first group: Five species of tree squirrels (including the flying squirrel), porcupine, raccoon, bear, two species of wildcat or lynx, panther, gray fox, fisher and wolverene. Since much of the forest that once covered more than half of the State has been cleared away, we should expect to find that many of these species are either reduced in number or exterminated. The facts are that seven of the 14 species—porcupine, two lynxes, panther, bear, pine marten and wolverene, are exterminated or nearly so. Of the remaining seven, the flying squirrel and the red squirrel have undoubtedly held their own in point of numbers and may have even increased because they are too small to be much sought after by man, and their natural enemies have decreased. The other three species of squirrel, the raccoon and the gray fox have greatly diminished in numbers, because they have been killed by man and at the same time their available food and habitat have diminished.

The 13 species that live chiefly in grassy regions are as follows: Jumping mouse, pouched gopher, three species of voles or meadow mice, prairie white-footed mouse, two species of spermophiles or ground squirrels, small shrew, star-nosed mole, coyote, badger and bison. Not deducting for pasture and meadow, the total area covered by grass has probably increased rather than decreased, since the first settlement of the State. This would enable these animals to increase in number if food were the only factor affecting them.

However, the bison was the first species to become extinct. A number of factors combined to bring about its extermination. The great size and strength of the individuals and their association in immense herds had made the bison practically immune from danger of its natural enemies; therefore, cunning had been of no value and timidity was at a discount.

Of the other grass-dwelling species, the badger appears to be almost extinct in our State. It is carnivorous and not directly dependent on grass for food, but is a true inhabitant of the prairie. Badgers were never numerous in this State, and their extermination is of little consequence to the fauna.

PLATE I.—A woodland habitat of the type common when the State was first settled, but now almost gone. University Farm, Mitchell, Indiana.

PLATE II.—A woodland habitat with large trees and little underbrush. University Farm, Mitchell, Indiana.

The coyote occupies an anomalous position in that it had almost disappeared from the State thirty years ago, but has again become numerous in many localities during the last decade. The increase in numbers is no doubt an adaptation to the presence of man. Those individuals that were able to "lie low" and escape observation have remained, while others were killed off or driven out. Although the number of coyotes in Indiana at the present time is no doubt less than before the settlement of the State, the species is to be classed with those that are now increasing.

The ten remaining species of this group are all small in size and inconspicuous. They are not numerous in cultivated fields, and numbers of them are killed by man, although they inhabit fence rows and thickets everywhere. Direct evidence as to their former number is lacking, but voles, white-footed mice and ground squirrels have probably increased since the country was first settled because their natural enemies have decreased and their small size and retiring habits enable them to escape coming into serious conflict with man. The other species were never numerous and have neither increased nor decreased to a marked degree.

The third group, those whose habitat embraces both wooded and grassy tracts, includes twenty-three species. Two of this group, the elk and deer, have been exterminated on account of their size, their inability to hide and their food value. The timber wolf is practically extinct, as is also the otter. The former was considered an enemy of man; the latter has been killed for its fur. In thickly settled districts the opossum, rabbit, mink, weasel and two species of skunk have also been partly crowded out and some of them are all but exterminated in certain localities. In other localities where the ground is rough and still wooded most of these species have held their own fairly well. Indeed, there are places in southern Indiana where rabbits are as numerous as they ever were and skunks and weasels have not greatly decreased in number.

The red fox, which also belongs in this group, has decreased in numbers in recent years in thickly settled regions, but there is strong evidence that the numbers of this species greatly increased when the country was first settled, if, indeed, it was not introduced from Europe. It is well adapted by its cunning to live in close proximity to man, and abounds even where the land is nearly all under cultivation. In this it affords a striking contrast to its cousin, the gray fox, which was once abundant, but is now almost extinct.

The woodchuck and chipmunk have certainly increased in num-

bers. This is due in part to their shy disposition, small economic importance, and the destruction of their natural enemies.

The white-footed mice, two voles, four shrews and mole, which are the remaining species of the group, are all small and inconspicuous. Evidence as to their former abundance is not at hand, but it is very probable that they have increased rather than diminished. It should be noted, however, that very little is known concerning the habits and habitat of the long-tailed shrews (*Sorex*) in this State, and on account of their rarity they should perhaps be included among those that are holding their own.

In the last group of 16 species I have included the beaver, muskrat and water hare, the introduced mice and rats and the bats. The first of these species disappeared early, being killed for the value of its fur and castoreum. Its habit of congregating in large communities about the water aided in its extermination. Repeated breakings of the beaver dams often caused the animals to leave a locality where they were disturbed, even though some of the colony escaped the trappers.

The muskrat has habits similar to those of the beaver, but it is not trapped so persistently, because its fur is less valuable. It reproduces much more rapidly and adapts itself more readily to its surroundings. Therefore, muskrats have been able to survive in every part of the State, and their numbers have been reduced more on account of draining the swamps than because of killing the animals.

Four species of the mouse family have been introduced by man. The black rat came with the earliest settlers and was driven out in the first half of the last century by the larger Norway rat. More recently individuals have been reintroduced but have not become reëstablished. The Norway rat and house mouse have been household pests for centuries and are able to hold their own in the immediate surroundings of man. A red rat has been occasionally introduced with fruit brought from the tropics, but has never become established.

The nine species of bats constitute a peculiar part of the fauna of the State. They make their homes in hollow trees, garrets, deserted buildings and caves. The guides at Wyandotte Cave state that they are less numerous there than formerly, but I have no other evidence as to the present and past numbers of these animals, and there is little reason to believe that they have either increased or decreased in number.

In summarizing the above facts (see table) it must be admitted

A grassy slope, partly filled with brush; the home of *Peromyscus leucopus noveboracensis*, *Zapus hudsonius*, *Synaptomys cooperi stonei* and *Blarina brevicauda*. Near Roselawn, Newton County

An adjacent marsh with the uncovered runway of *Microtus pennsylvanicus* under the coarse marsh grass. Near Roselawn, Newton County.

that we have very meager evidence concerning the former abundance of many of the species. The small species easily escape notice and many of them are not mentioned by the early naturalists of the State. However, by taking into consideration the facts positively known concerning some of the larger species and such evidence as we may be able to obtain from the present distribution and ecological relations of the other species, the following conclusions may be stated: Fourteen species have been practically exterminated. These have all been animals of large or medium size, or they have been of considerable economic importance. Their extermination has been directly due to the destructive work of man, although this has been accomplished in some instances by a reduction in the available habitat and food supply. Sixteen other species have been greatly reduced in numbers. Some of these will be exterminated in the course of time, while others may become more fully adapted to man and, in the case of the squirrels, they may become semi-domesticated. These sixteen species are all of medium size and most of them have some value for fur or food.

Seventeen species are holding their own fairly well, so far as we can tell from the evidence that is obtainable. Some of these may have been reduced in numbers to some extent, but on the whole they probably occupy about the same position in the fauna of the State that they did a century or two ago. This group is here extended to include several species concerning the numbers of which we have no conclusive evidence. These species are all of small size, or they are very prolific and well adapted to live in close association with man.

The nineteen remaining species have apparently increased in numbers since the coming of the white men. Besides the red fox, which all authorities say was rare during the period of early settlement, the group includes the introduced mouse and rats and most of the species of native mice which, because of their fecundity, small size and inconspicuous habits are better able to cope with man in the struggle for existence than with their smaller foes, the rapacious beasts and birds. Hence, when the carnivorous birds and mammals were lessened in numbers, the small and weak species were given an advantage.

Number.	SPECIES.	Habitat Chiefly Woodland.	Habitat Chiefly Fields.	Habitat Both Forest and Field.	Species Occurring for Some Special Reason.	Exterminated.	Partly Exterminated.	Numbers Stationary.	Numbers Increased.
1	*Didelphis virginiana*			+			+		
2	*Bison bison*		+			+			
3	*Cervus canadensis*			+		+			
4	*Odocoileus virginianus*			+		+			
5	*Sciurus carolinensis*	+					+		
6	*Sciurus carolinensis leucotis*	+					+		
7	*Sciurus niger rufiventer*	+					+		
8	*Sciurus hudsonicus loquax*	+						+	
9	*Tamias striatus*			+					+
10	*Citellus tridecemlineatus*		+						+
11	*Citellus franklinii*		+						+
12	*Marmota monax*			+					+
13	*Sciuropterus volans*	+						+	
14	*Castor canadensis carolinensis*				+	+			
15	*Mus musculus*				+a				+
16	*Mus norvegicus*				+a				+
17	*Mus rattus*				+a	+			
18	*Peromyscus leucopus*			+					+
19	*Peromyscus leucopus noveboracencis*			+					+
20	*Peromyscus maniculatus bairdi*		+						+
21	*Nyctomys decolorus*				+a	+			
22	*Microtus pinetorum auricularis*			+					+
23	*Microtus pinetorum scalopsoides*			+					+
24	*Microtus pennsylvanicus*		+						+
25	*Microtus ochrogaster*		+						+
26	*Synaptomys cooperi stonei*		+						+
27	*Fiber zibethicus*				+		+		
28	*Zapus hudsonius*		+					+	
29	*Erethizon dorsatus*	+				+			
30	*Geomys bursarius*		+					+	
31	*Sylvilagus floridanus mearnsi*			+			+		
32	*Lepus aquaticus*				+		+		
33	*Felis cougar*	+				+			
34	*Lynx canadensis*	+				+			
35	*Lynx ruffus*	+				+			
36	*Urocyon cinereo-argentatus*	+					+		
37	*Vulpes fulvus*			+					+
38	*Canis latrans*		+						+
39	*Canis occidentalis*			+			+		
40	*Lutra hudsonica lataxina*			+			+		
41	*Mustela pennanti*	+				+			
42	*Lutreola vison*			+			+		
43	*Putorius noveboracencis*			+			+		
44	*Gulo luscus*	+				+			
45	*Taxidea taxus*		+				+		
46	*Mephitis putida*			+			+		
47	*Mephitis mesomelas avia*			+			+		
48	*Spilogale putorius*			+			+		
49	*Procyon lotor*	+					+		
50	*Ursus americanus*	+				+			
51	*Condylura cristata*		+					+	
52	*Scalops aquaticus machrinus*			+					+
53	*Blarina brevicauda*			+					+
54	*Blarina brevicauda carolinensis*			+					+
55	*Blarina parva*		+					+	
56	*Sorex personatus*			+				+	
57	*Sorex longirostris*			+				+	
58	*Corynorhinus macrotis*				+			+	
59	*Myotis grisescens*				+			+	
60	*Myotis subulatus*				+			+	
61	*Myotis lucifugus*				+			+	
62	*Pipistrellus subflavus*				+			+	
63	*Lasionycteris noctivagans*				+			+	
64	*Lasiurus borealis*				+			+	
65	*Lasiurus cinereus*				+			+	
66	*Eptesicus fuscus*				+			+	
	Totals	14	13	23	16	14	16	17	19

a Introduced.

It will be noticed that the bats were placed in the group which have held their own rather than with those which have multiplied. This is because they are so thoroughly adapted to the conditions in which they live that no natural enemies were ever able to prey upon them to a great extent, and they have been neither benefited nor injured by man.

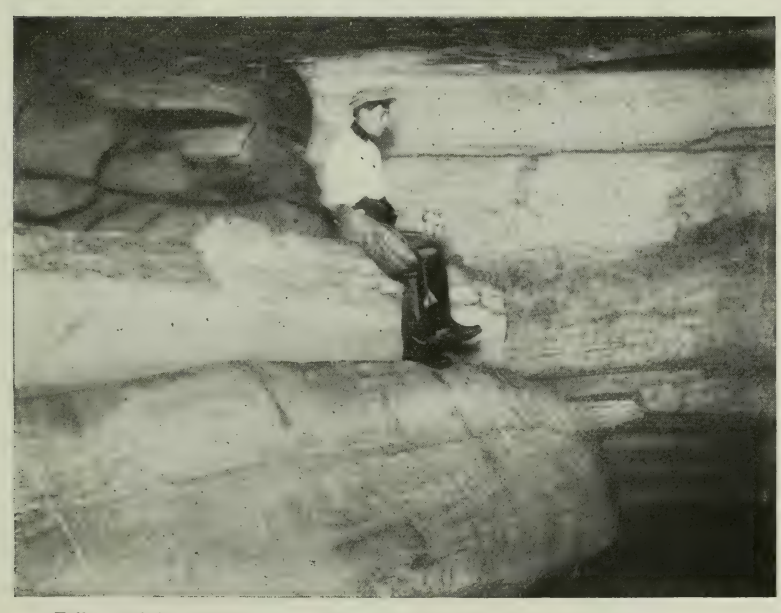
Since the primeval forest has been almost completely cut down, we might expect that the forest dwelling species would be most affected by man. The above table shows that this is the case. Fifty per cent. of the species have entirely disappeared, almost 36 per cent. have diminished in numbers, and the remaining 14 per cent. have, probably, just held their own. Of the grass inhabiting animals one species, or less than 8 per cent., have been exterminated. The same number has been partly exterminated, four species or about 24 per cent., have about held their own, while about 60 per cent. have probably increased in number.

On the assumption that species with generalized habits have the advantage, it would seem that the animals living in both forest and field would hold their own better than any others. Examination shows, however, that several of these species are large and others are fur-bearers. Both qualities are a disadvantage to an animal when it comes into conflict with man. Two species, or 8 2-3 per cent., have been exterminated, and the same number have remained stationary. Thirty-six per cent. have materially decreased and 40 per cent. have increased. Of the introduced species, two have become established and two have not, while no general conclusions can be drawn concerning the others of this category.

For a clearer understanding of ecological relationships, it seems desirable to consider the individual as apart from the species, although it is, of course, impossible for the individual to live in an environment different from that of the species to which it belongs.

Every animal is thrown into contact with two more or less distinct environmental relations, the biological and the physical. The biological environment includes all of those living things which the animal may seek as food or as a mate, and also such creatures as may seek to use it for food or for a mate. The relationship is therefore an active one and the adjustment of the individual to its biological environment is a problem that, to animals of most species, is ever present, ever changing and never solved. When an animal becomes so perfectly adjusted to its biological environment that effort is no longer required to maintain the balance, the animal's mental faculties cease to develop. This has happened to many of

Entrance of Shawnee Cave, near Mitchell.



Fallen rock just within the entrance of Lower Twin Cave near Mitchell. Bats congregate near both of these places in large numbers.

PLATE IV.

the larger animals having a vegetarian diet and has been an important factor in their rapid extermination. For instance, a bison could always find an abundance of grass unless in case of events entirely beyond its control, such as extensive fires or prolonged and deep snows. The strength of the individual, together with the strength of the herd of which it was always a part, rendered each animal practically secure from attacks of all enemies. While there was some fighting for mates among the old males, the habit of associating in herds of great size made this struggle of secondary importance and the only way in which individuals were compelled to adapt themselves to the environment was by migrating to new feeding grounds as pastures were exhausted.

On the other hand, a carnivorous animal is always compelled to seek prey that is often nearly its equal in strength and speed. Here cunning is at a premium, and mental capacity may determine which individuals shall live and which shall perish.

The construction of a den or nest is also, to a large degree, an adaptation to the biological environment. The larger species of grass-eaters trust to speed and strength to escape enemies; their young are born in such a highly developed condition that they are able to walk and run about almost immediately, and no nest or den is ever constructed.

But the young of most other mammals are born in a naked and helpless condition. For their protection most animals construct some kind of a nest, sometimes first making a den or burrow in which to place it. This may be in part, for protection from the physical elements, but is more largely for protection from enemies. Nest-building is almost universal among the smaller rodents that are subjected to attacks from many enemies. However, bats that are equally helpless, spend most of the time on the wing or suspended from the roofs of caves or the sides of hollow trees where they are comparatively free from danger. Consequently they never construct any sort of nest or home, but carry their helpless young about from place to place or leave them clinging to the most convenient resting place.

The effects of home constructing upon an animal are of far-reaching consequence. The instinct and intelligence of the animal are brought into play in selecting the site and material, and the sense of ownership is developed and combative ability maintained in the defense of its home. The ownership of a home limits the range of an animal and gives it a base from which to extend its activities, just as the possession of a home gives a man stability and responsi-

bility. Indeed, it is not too much to assert that the aesthetic and moral senses of man have developed, wholly or largely, as the result of home constructing which is, from the standpoint of evolution, the first step in acquiring property.

It will be seen from the foregoing statements that the biological environment is the chief agency in developing the mental capacity of an animal. It is true that the struggle for existence is with the physical as well as the biological environment, but physical conditions are, to a very large extent, beyond the ability of an animal to modify or control.

Hence the range of the individual, as well as the distribution of the species, is determined principally by physical conditions. Of course the range may be limited by food supply, but no species is found in every place where it might secure food nor does it usually exhaust the supply. Rivers, lakes and smaller bodies of water are often barriers for individuals but not for the species. A mouse or shrew may live along the bank of a small stream and go no farther in one direction than the water, but in time the species will cross it or pass around it.

But there are other barriers that are less obvious. Certain of the meadow mice live in swampy places, and a low hill will ordinarily prove a barrier to one of these creatures although not to the species since they occasionally venture on the higher ground and often inhabit it in wet weather. Some of the ground squirrels live only in dry ground and a marsh proves an effective barrier for them. Other meadow mice live in grassy fields, and their food is principally the tender basal portions of the stems of grass and clover. They could secure plenty of food in a pasture or meadow, but they are rarely found in such places because they make tunnels or runways under dry, fallen grass and are seldom found about farms except along fence rows and in places where the grass is allowed to grow up and remain uncut. Here the grass constitutes a shelter and is to be regarded as having a physical rather than a biological relation to the animal.

Again, there are many animals that live in fields, and a strip of woodland will limit their range. On the other hand, squirrels and other tree dwellers are bounded by areas of prairie or open field. In such cases the species, sooner or later, cross or go around these barriers but this occurs only under unusual conditions, or after the lapse of a long period. To the average individual, living the average life, the limits of activity are much more narrowly circumscribed than they are for the species as a whole.

COLLECTING AND PRESERVING MAMMALS.

It is desirable that a school in which biology is taught, should have a collection of specimens of one or more groups of animals found in the vicinity. Mammals are more easily collected and prepared than birds, and the objections often and justly urged to allowing amateurs to collect birds cannot be urged with regard to mammals. On the other hand, the injurious character of the species of mice makes it desirable that their habits should be learned and many individuals destroyed. Much can be learned about their habits and anatomy while making a collection and preparing specimens.

Excellent directions for preparing specimens of small mammals for study purposes have been published by the United States National Museum at Washington, D. C. These directions, which constitute part N of Bulletin 39, are sent free to schools, teachers or others seriously interested in the study of mammals. The following remarks are condensed from them.

For the study of mammals, the dried and stuffed skins and the cleaned skulls are necessary. The small mammals, such as mice, shrews, ground squirrels, weasels, etc., are most easily collected by trapping. For the smaller species the best trap is the ordinary mouse trap made with a spring fastened on a wooden block and variously known as the "out-o'-sight," "cyclone," "lightning," etc. Most of these are very poorly made, however, and last but a short time if used out of doors where they get wet. A much better (and also more expensive) trap is constructed on the same principle by the Animal Trap Company of Lititz, Pennsylvania, especially for collectors. Rat traps of the same style are suited for catching ground squirrels. The wild mice do not readily enter cage or box traps designed for capturing animals alive.

The fur-bearing animals can be taken in unbaited steel traps set in the entrance of their dens or in paths frequented by them along streams or in the roads. Dry, uncooked rolled oats makes an excellent bait for most small mammals and cheese and nuts are also good.

Mammals spoil more quickly than birds and should be skinned as soon as possible after being caught. In the summer it is necessary to visit traps twice a day, in the evening to replenish bait that insects may have eaten, and in the morning before the hot sun shines on specimens that are caught. In cold weather it is not necessary to visit them more than once a day or once in two days.

Before skinning the animal, three measurements should be taken

(Fig. 1): (1) From the tip of the nose to the tip of the tail (without measuring the hairs) with the animal extended at full length, but not stretched. (2) The tail, from its junction with the body, when pulled at right angles with the body, to the tip. (3) The hind foot from the heel joint to the most distant claw tip. It is desirable that the measurements be given in millimeters and that they be put on the label in the order named above for the sake of convenience in comparing with the measurements of other collectors. Measurements can be made more accurately with a pair of dividers than with a rule or tape alone.

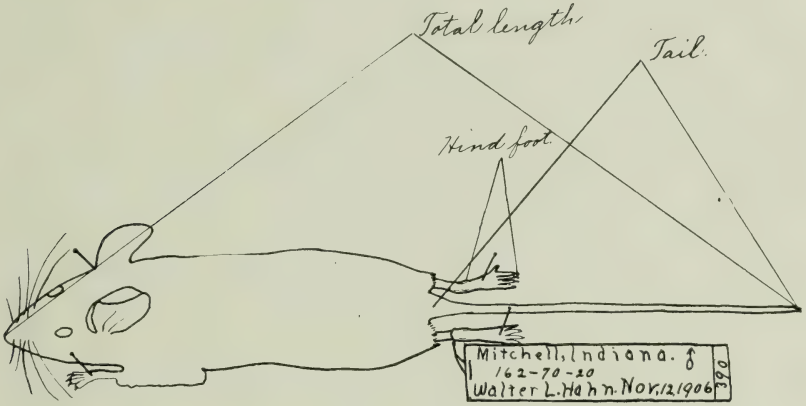


FIG. 1.—Diagram of a mouse, showing measurements to be taken and method of pinning and labeling a skin.

To skin a mammal, lay it on its back and with a pair of small scissors slit the skin along the middle of the belly from the tail to the breast bone. With the fingers, work the skin back from the body and along the sides to the hind legs, and by bending the legs at the knee joint, work the skin off all the way around each of them and sever the leg from the body near the knee. Push the skin back along each leg to the foot and, with a knife and scissors, strip the fleshs and tendons from the bone. In animals no larger than a rat, it will be sufficient to skin the leg down to the ankle joint, but in larger ones the tendons and flesh should be taken out of the foot also. By placing the finger nails, a pair of forceps or sticks about the base of the tail inside the skin, the skin can be pulled off of the tail except in the muskrat and a few other fleshy-tailed animals where it must be laboriously cut off. The bones should always be removed from the tail.

When the tail and hind legs are free, turn the skin back over the

body and work it off, as a glove is removed, being careful not to stretch it. The front legs should be skinned in the same way as the hind ones. The ears should be cut off under the skin close to the head and care is necessary in getting all of the skin off around the eyes and mouth without cutting it; a knife or a pair of small scissors must be employed here to get it free. To prevent blood and grease from soiling the fur, cornmeal may be sprinkled plentifully on the body and the inside of the skin, although no harm is done by washing a skin if it is properly dried and the hairs combed and brushed before the drying process is complete.

The skin is now completely removed and is wrong side out. Carefully remove all fat and flesh. Next poison the inside by rubbing over it dry arsenic or a mixture of arsenic and powdered alum; either will preserve the skin from decay and help to keep insects from eating it.

Next turn the skin right side out. Cut five pieces of galvanized wire (No. 23 for a mouse, and for larger animals wire in proportion to their size) of the right length to reach from the tip of the tail and the sole of each foot to the middle of the body. Wrap the tail wire tightly with cotton till it is the size of the tail bone and carefully push it in the skin of the tail to the tip. Put a wire in each of the legs, pushing it down along the bone inside of the skin to the sole of the foot. Wrap the upper part of the leg bone, together with the wire, with cotton till it is the size of the leg before skinning. Next roll together a quantity of cotton the size and shape of the head and body of the animal and with a pair of small forceps, insert it into the skin, pushing it down to the nose, and inserting the ends of the tail and leg wires into the middle of it.

The hair should be smoothed and the body pushed and pinched into symmetry, the mouth closed with a stitch through the lips and the slit in the belly sewed up. When the skin is completed the front legs should be drawn forward parallel to the neck and the hind ones backward parallel to the tail as shown in figure 1. It is a mistake for any one who has had no instruction in taxidermy to attempt to mount a skin with the feet under the body in a natural standing position. Flat skins are just as good for study, require less room, are less easily damaged and usually more artistic than a "mount" made by an amateur. In order to hold their shape they should be pinned on a board and placed to dry where the air circulates freely. Two or three days are usually required to thoroughly dry a small skin and a longer time for larger skins.

The skull is also to be preserved. It may be cut off of the body, dipped in dry arsenic and hung up to dry, or it may be cleaned at once. To clean it, the skull must be boiled till the flesh is tender enough to scrape off. The skulls of small mammals are delicate and the first attempt to clean them is almost certain to result in the breaking of some of the small bones of the palate, if indeed, the entire skull is not destroyed in removing the brain. The latter operation can best be done by using a small wire with one end bent at right angles to the rest and hammered flat. For scraping the flesh from a skull, a small knife will answer and a tooth brush is useful in brushing away loose particles of flesh and cleaning angles after most of the flesh is removed. The forceps which usually accompany a dissecting set will be found useful at many points in the operation. A small amount of washing soda or potash boiled with the skulls makes them easier to clean, but these substances cause the sutures to open and must be used sparingly. Skill can only be acquired by practice and it is surprising to know how much longer it takes to skin and clean the skull of the first animal than it does to accomplish the same work after a little practice.

It is necessary to attach a label to both skin and skull and to give them each the same number in order that their history and identity may not be lost. On the label should be written the locality and date of capture, the sex of the animal, the measurements and the name of the collector, together with a serial number which he gives to each of his specimens (Fig. 1). The date is essential because the color, as well as the length and density of the hair, varies with the season and two or more species have sometimes been described from specimens which differed greatly in appearance because they were taken at different seasons. Among some groups, the sexes differ greatly in appearance and size and hence it is important to know the sex of a specimen. Conventional signs are generally used on a label, the Venus mirror ♀ indicating a female and the sign of Mars ♂ a male. It is well to record in a permanent note book the same data, together with other information concerning the exact place and circumstances of capture or other notes of interest.

If there is no time for skinning mammals, they can be slit open and dropped into alcohol, 80 to 85 per cent., or formalin, 2 to 3 per cent., and treated the same as fishes or other zoological specimens. However, the fluids extract color from the hair and dry specimens are in every way better.

Skeletons of mammals are also of value for study. To prepare

them, the internal organs and large masses of flesh are removed and the bones are cleaned in the same way as skulls. Small skeletons are extremely difficult to prepare and those the size of a dog or fox are better for study.

CLASSIFICATION.

The old idea of a species as a group of animals separated from all other groups by characters which are constant and unchanging, has given way to the idea that species are constantly changing and often intergrade. When large collections are brought together from adjoining regions it is often found that the average color, size or other characters of specimens from one locality differ from the average of specimens from another locality, although there may be individuals from either place that bridge the difference. These average characters are now generally considered to be of considerable significance and when a number of them are fairly constant for any circumscribed region, they are recognized as being sufficient to distinguish species or subspecies.

It follows, therefore, that individual specimens cannot always be assigned with any certainty to one species or another. However, the purpose of systematic zoology is not to put every animal into a pigeon-hole, properly labeled with a latin name, but to study variations, their causes and their significance to the biological processes. Yet it does not follow that the study of species has no value. If the amateur is unable to determine certainly to which subspecies an animal belongs, he should not be discouraged or feel that the specimen has no value. Its chief value to him will not be in the name which belongs to it as a stuffed skin, but in the relation which it bore to its environment as a living animal.

It is hoped that the following keys will enable anyone with a little knowledge of biology to identify any mammal found in Indiana with a reasonable degree of accuracy when the skin and skull are before him. The larger museums are usually willing to identify and return to the owner any specimens which are submitted to them, especially if duplicates to be kept by the museum are included. The keys are intended to apply only to species that have been recorded from this State or that are likely to be found within its borders. Some of the points in the key and the definitions of the groups will not hold true for mammals in general.

The arrangement of the key does not follow any natural order of classification and has been planned solely for the purpose of

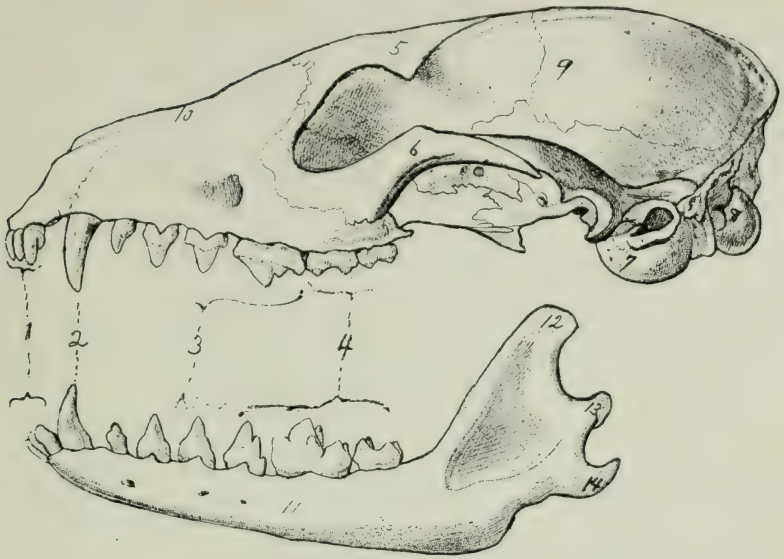


FIG. 2.—The skull of a carnivorous mammal (gray fox). 1, incisor teeth; 2, canine; 3, premolars; 4, molars; 5, postorbital process of skull; 6, zygomatic arch; 7, audital bulla; 8, occipital condyle; 9, braincase; 10, rostrum; 11, mandible; 12, coronoid process; 13, condyloid process; 14, angular process.

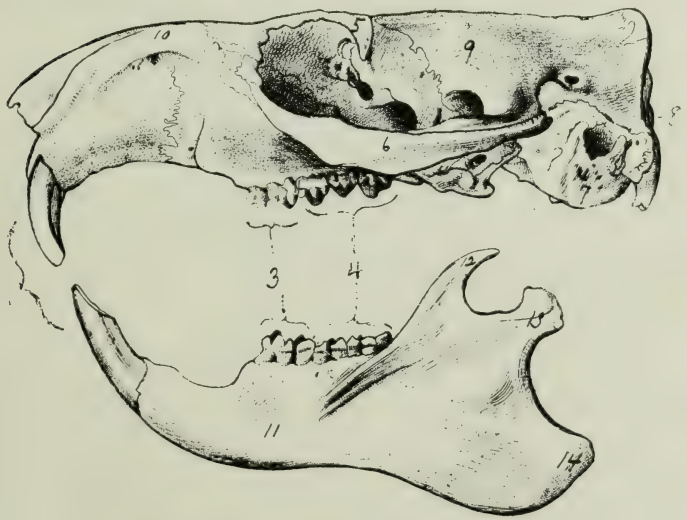


FIG. 3.—Skull of a rodent (the woodchuck). 1, incisors; 3, premolars; 4, molars; 5, postorbital process; 6, zygomatic arch; 7, audital bulla; 8, occipital condyle; 9, braincase; 10, rostrum; 11, mandible; 12, coronoid process; 13, condyloid process; 14, angular process.

enabling the student to identify mammals with the smallest possible labor. Where a genus is represented by more than one species in the State, keys to the species will be found under the genus. External and easily distinguished characters have been used as far as possible, although in some cases skulls and teeth are essential and they are always desirable in establishing the identity of any mammal. (See figures 2 and 3 for parts of the skull.)

KEY TO ORDERS, FAMILIES AND GENERA.

(NOTE.—I = incisor teeth; C = canines; Pm = premolars; M = molars. See figures 2 and 3.)

A. Fore limb modified into a wing with an elastic membrane stretched between the long digits and also between the arm and the body. (Bats.) Order CHIROPTERA and Family VESPERTILIONIDAE, p. 616

B. Ears more than one inch long, partly united in front of the head. Genus *Corynorhinus*, p. 617

BB. Ears considerably less than one inch long, widely separated in front.

C. Membrane between the hind legs about as thickly furred on top as the body. Genus *Lasiurus*, p. 633

CC. Membrane between hind legs so scantily furred that the skin is distinctly visible.

D. Fur blackish with whitish tips that give it a frosted appearance (teeth on each side, I, $\frac{2}{3}$; C, $\frac{1}{1}$; Pm, $\frac{2}{3}$; M, $\frac{3}{3}$). Genus *Lasionycteris*, p. 626

DD. Fur without frosting; teeth not as above.

E. Size very small; color yellowish brown (teeth, I, $\frac{2}{2}$; C, $\frac{1}{1}$; Pm, $\frac{2}{2}$; M, $\frac{3}{3}$.) Genus *Pipistrellus*, p. 629

EE. Color darker brown; teeth different.

F. Size large (total length more than four inches) teeth, I, $\frac{2}{3}$; C, $\frac{1}{1}$; Pm, $\frac{1}{2}$; M, $\frac{3}{3}$. Genus *Eptesicus*, p. 631

FF. Size smaller; total length less than 4 inches.

G. Upper incisors 4; common cave species. Genus *Myotis*, p. 620

GG. Upper incisors 2; rare or perhaps absent from our fauna. Genus *Nycticeius*, Appendix, p. 648

AA. Both pairs of limbs adapted for walking or running; no wings.

B. Inner toe of hind foot widely separated from the rest, like a thumb and without a sharp claw; teats of female opening inside a pouch on the abdomen; upper incisors ten. (Opossum). Subclass METATHERIA, Order MARSUPIALIA and Family DIDELPHIDAE. Genus *Didelphis*, p. 448

BB. Hind feet not as above; no pouch beneath the abdomen; upper incisors less than ten. Subclass EUTHERIA.*

C. Feet all terminating in hoofs (bison and deer). Order UNGULATA, p. 451

D. Horns hollow, permanent and growing throughout life. Family *Bovidae*, Genus *Bison*, p. 452

*The bats, at the beginning of the key, also belong to the EUTHERIA.

DD. Horns (antlers) solid and shed each year. (Deer, elk, etc.)
Family CERVIDAE, p. 454

E. Size large; height at shoulder about five feet; antler four to five feet in length (Wapiti or elk).
Genus *Cervus*, p. 454

EE. Size smaller; height at shoulder about three feet; antler one and a half to two feet. (Deer)
Genus *Odocoileus*, p. 457

CC. No hoofs; toes with claws.

D. Front teeth chisel shaped and separated from the remainder of the teeth by a wide space, filled by an infolding of the lips. (In the rabbits there are four front teeth in the upper jaw, one pair directly behind the other. All other members of the order have but two incisors above and two below.) (Gnawing animals.) Order **GLIRES**, p. 460

E. Two pairs of upper incisors, the one behind the other. (Hares and rabbits.) Family LEPORIDAE, p. 533

F. Size large; hind foot five inches or longer.
Genus *Lepus*, p. 537

FF. Size smaller; hind foot less than four and a half inches; common rabbits. Genus *Sylvilagus*, p. 533

EE. One pair of upper incisors.

F. Tail horizontally flattened, without hairs; size large. (Beavers.)
Family CASTORIDAE, Genus *Castor*, p. 487

FF. Tail round or slightly flattened at the sides.

G. Fur mixed with stiff spines or quills. (Porcupines.)
Family ERETHIZONTIDAE, Genus *Erethizon*, p. 530

GG. Fur without quills or stiff spines.

H. With external cheek pouches which open outside the mouth; claws very long; tail short and nearly naked; form and habits of moles. (Pocket Gophers.)
Family GEOMYIDAE, Genus *Geomys*, p. 524

HH. No external cheek pouches; claws shorter.

I. Four or more grinding teeth in each jaw; tail with long hairs, often bushy. (Squirrels, etc.)
Family SCIURIDAE, p. 460

J. Fur very soft and dense; a thickly furred membrane along the side between the fore and hind legs. (Flying squirrels.)
Genus *Sciuropterus*, p. 484

JJ. No membrane along the sides.

K. Body short and heavy; skull broad and flat on top. (Woodchucks.)
Genus *Marmota*, p. 479

KK. Body slender; head and skull more rounded.

L. Tail bushy; no pouches opening inside cheeks; homes in trees; no stripes on back. (Tree squirrels.)
Genus *Sciurus*, p. 460

LL. Tail not very bushy; pouches opening between teeth and skin of cheek; homes in ground.

M. General color of body rich chestnut brown with stripes of blackish and whitish; four grinding teeth on each side of upper jaw. (Chipmunk.)
Genus *Tamias*, p. 470

MM. General color dull grayish brown; five grinding teeth in the upper jaw. (Spermophiles, often called "gophers.")
Genus *Citellus*, p. 475

II. Never more than three grinding teeth in lower jaw; tail slender and round, with hairs short and lying close to the skin, or tail almost devoid of hairs. (Rats and mice.)

J. Hind feet and tail very long; upper jaw teeth four; (head and body about three inches, tail over four inches and hind foot more than one inch). (Jumping mice.)
Family ZAPODIDAE, Genus *Zapus*, p. 527

JJ. Hind foot and tail proportionately shorter, upper jaw teeth three. Family MURIDAE.

K. Upper incisors with grooves down the front.

L. Form thick set, with short legs, short ears, and tail less than one inch.
Genus *Synaptomys*, p. 521

LL. Proportions about as in the common house mouse, but smaller.
Genus *Reithrodontomys*, Appendix, p. 640

KK. Upper incisors without grooves.

L. Habits aquatic; tail long and flattened at the sides. (Muskrat.)
Genus *Fiber*, p. 517

LL. Not aquatic; tail round.

M. Form stout, with short legs and ears; tail not over half as long as head and body; crowns of molars with loops and triangles. (Meadow mice.)

N. Color rusty reddish on back; molars rootless. (Rare or absent from Indiana.)
Genus *Evotomys*, Appendix, p. 642

NN. Color brownish or grayish; molars rooted. (Common meadow mice.)
Genus *Microtus*, p. 505

MM. Legs and ears of moderate length; tail more than half as long as head and body; crowns of molars with tubercles.

N. Molars with tubercles in two rows (these may be worn off in old animals). (House mice and house and wharf rats.)
Genus *Mus*, p. 491

NN. Tubercles of molars in three rows; native mice of the fields and woods.

O. Size and proportions about as in the house mouse; belly pure white; eyes and ears large. (White-footed mice; common.)
Genus *Peromyscus*, p. 495

OO. Size larger; species of doubtful occurrence or introduced into the state.

P. Color of back bright reddish; belly white; introduced species from the tropics.
Genus *Nyctomys*, p. 503

PP. Found in caves and rocky cliffs; belly pure white; about the size of a house rat.
Genus *Neotoma*, Appendix, p. 641

PPP. Found about water; smaller; belly grayish.
Genus *Oryzomys*, Appendix, p. 640

DD. Tooth row continuous from incisors to last molar, front teeth not chisel-shaped. (In the moles the upper front teeth are always large and somewhat chisel-shaped, but the characters given under the family easily distinguish them.)

E. Size small (total length under ten inches); eyes very small; snout pointed. (Moles and shrews, generally with burrowing habits.)
Order INSECTIVORA, p. 597

F. Fore feet very broad and flat; length of adults always over five inches. (Moles.)
Family TALPIDAE, p. 608

G. A star of fleshy projections around the nose; teeth, I, $\frac{3}{3}$; C, $\frac{1}{1}$; Pm, $\frac{4}{4}$; M, $\frac{3}{3}$.
Genus *Condylura*, p. 613

GG. No fleshy star about nose; teeth not as above.

H. Tail slender, scantily haired; teeth, I, $\frac{3}{2}$; C, $\frac{1}{0}$; Pm, $\frac{3}{3}$; M, $\frac{3}{3}$. (Common moles.)
Genus *Scalops*, p. 610

HH. Tail thick and fleshy; teeth, I, $\frac{3}{3}$; C, $\frac{1}{1}$; Pm, $\frac{4}{4}$; M, $\frac{3}{3}$. (Of doubtful occurrence in Indiana).
Genus *Parascalops*, Appendix, p. 647

FF. Fore feet not broad (similar to those of a mouse); size not over five inches. (Shrews.)
Family SORICIDAE, p. 597

G. Tail about one-fourth as long as head and body; ears small but easily seen. Genus *Blarina*, p. 597

GG. Tail at least half as long as head and body, external ears scarcely distinguishable.
Genus *Sorex*, p. 604

EE. Size larger (length 12 inches or more*); eyes well developed; snout not especially sharp. (Carnivorous animals.)
Order FERAE, p. 539

F. Size very large, with clumsy, thick-set form; tail rudimentary. (Bears.)
Family URSIDAE, and Genus *Ursus*, p. 592

FF. Size medium or small; form slender, tail well developed.

G. Claws retractile into a sheath of the toes; fitted for climbing; muzzle broad and short, (Panthers, wildcats, etc.). Family FELIDAE, p. 539

H. Tail at least one third as long as head and body; teeth 30. Genus *Felis*, p. 540

HH. Tail not over one fifth as long as head and body; teeth only 28. Genus *Lynx*, p. 543

GG. Claws not retractile; snout less blunt.

H. Body thick-set; feet plantigrade; tail with alternate rings of light and dark hairs. (Raccoons.)
Family PROCYONIDAE, Genus *Procyon*, p. 588

HH. Feet not plantigrade; tail not ringed.

I. Hind foot with five toes.
Family MUSTELIDAE, p. 565

J. Toes webbed; habits aquatic. (Otters.)
Genus *Lutra*, p. 565

JJ. Toes not webbed; not aquatic.

K. Colors black and white; highly developed scent glands present which are used for defense. (Skunks.)

L. White of body in one or two broad, connected stripes; form thick-set. (Common skunks.)
Genus *Mephitis*, p. 569

LL. White of body in several narrow, disconnected lines and spots; form more slender. Genus *Spilogale*, p. 575

KK. Colors not black and white; scent glands not used for active defense.

*The least weasel, however, measures but 7 inches.

L. Color yellowish gray; claws very long. (Badger.) Genus *Taxidea*, p. 577

LL. Color brown (in some species white in winter).

M. Body stout with legs and tail short; foot plantigrade, as in bears. (Wolverine, not now found in the state.) Genus *Gulo*, p. 579

MM. Form slender and graceful with long tail and slender legs.

N. Size large; length 20 inches or more. (Mink.) Genus *Lutreola*, p. 581

NN. Size smaller; not over 18 inches. (Weasels). Genus *Putorius*, p. 584

II. Hind feet with only four toes; head somewhat pointed. (Wolves, foxes, etc.). Family CANIDAE, p. 547

J. Size large; length not less than 45 inches; upper incisors divided into lobes. (Wolves and coyotes.) Genus *Canis*, p. 557

JJ. Size smaller, less than 45 inches; upper incisors not lobed. (Foxes.)

K. Hairs of tail soft like those of body; sides rusty red; skull rounded on top. Genus *Vulpes*, p. 551

KK. Tail with a mane of stiff hairs on back; back and sides grayish; skull flat on top. Genus *Urocyon*, p. 547

Order MARSUPIALIA.

MARSUPIALS.

Mammals in which the young are born before development has progressed far. Young placed in a pouch on the abdomen of the mother where they are nourished by milk which she forces out of her teats into their attached mouths by muscular contraction. Brain small and rudimentary. Pelvis with two small separate (marsupial) bones projecting forward from the pubes.

The Marsupials are mammals which, in the process of evolution, stopped before they had reached the complex condition now attained by their relatives. The principal difference is found in the reproductive organs. The organs of the female are all duplicated, almost to the external opening, instead of joining in a common uterus as in other mammals. The fertilized ova develop without the formation of any special structure (placenta) for the at-

tachment of the embryo to the uterus and the young are born in a very rudimentary condition.

The earliest mammals, geologically, of which we have any knowledge are marsupials. The lack of specialization in some members of the order has enabled them to become adapted to changing conditions and they have survived with very few changes since Miocene times. The order is now limited in distribution to America and Australia.

Family DIDELPHIDAE.

OPOSSUMS.

This family includes all of the marsupials of North and South America, to which continents it is limited. It is characterized by the presence of 50 teeth, five toes on each foot, the first toe of the hind foot being widely separated from the rest, and a long scaly, prehensile tail.

Genus DIDELPHIS Linnaeus.

Dental Formula.—I, $\frac{5-5}{4-4}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{3-3}{3-3}$; M, $\frac{4-4}{4-4} = 50$.

Generic characters.—A complete marsupium or pouch on the abdomen of the female in which the young are placed immediately after birth; young born at a very early stage when development is less advanced than in most mammals. Tail prehensile, densely haired at the base but nearly naked on the outer two-thirds. Inner toe of hind foot somewhat opposable to other toes. Five digits on both fore and hind feet.

Skull elongated, with a high sagittal crest, pointed rostrum, and numerous teeth.

The genus has a range extending from the northern United States to Middle South America and is represented by a number of species. Only a single form occurs in the eastern United States north of Florida.

1. DIDELPHIS VIRGINIANA Kerr.

OPOSSUM.

Didelphis virginiana Kerr, Animal Kingdom, p. 193, 1792. Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 124, 1894.

Didelphis marsupialis Miller and Rehn, Proc. Bost. Soc. Nat. Hist., p. 7, 1901.

Diagnostic characters.—Easily distinguished from any other animal found in the State by the marsupium of the female, the op-

posable first toe of the hind foot, the scantily haired, scaly tail, the long pointed snout and the large number of teeth.

Description.—The color is extremely variable, some individuals being nearly white and others almost black. Face white or pale gray with a dark streak running forward from the occiput to the eyes and a ring of black around them. The body fur is of two kinds, a short, dense coat of wooly hairs, and a longer, thinner coat of coarse hairs. The under fur is usually white or slightly yellowish at the base and is tipped with black. The long hairs are usually gray, giving to the entire coat a grizzled effect. Melanistic individuals, having the long hairs black are not rare.

The ears are broad and naked except for a few minute hairs, and are usually blackish in color but sometimes edged or tipped with white. Palms, soles and toes flesh color; upper surface of fore and hind feet black. Base of tail densely furred for about two inches, then naked and black for about two inches; the remainder naked and flesh color, or with a few spots of blackish.

Measurements.—Six specimens taken by the writer at Mitchell averaged 600 mm. (24 inches) in total length; tail 235 mm. (9½ in.); hind foot 55.5 mm. (2 3/16 in.). None of these specimens were fully matured, however, and the adults reach a length of 28 inches with other measurements proportionally increased.

Skull and teeth.—Skull elongated, with a well developed sagittal crest, even in immature animals; braincase small and scarcely elevated above the frontal region; zygomatic arches strong and divergent; palate perforated in the posterior part. Incisors small and weak; canines strong, largest in old males; premolars shaped somewhat like the canines. Posterior molars not appearing till late. The molars do not wear down rapidly but retain the prominent cusps, even in old animals.

Range.—The species is found from Connecticut and the Great Lakes to the Gulf coast and west to the great plains. Slightly different forms occur in Florida and the southwest. In Indiana it occurs throughout the State with the possible exception of some limited areas in the northern portion where it seems to have become extinct, but it is most abundant in the southern part.

Habits.—The opossum is one of the few animals capable of adapting itself to almost any sort of condition. In the long run, with changing climate and fauna and flora, the animal with generalized habits and structure has a much better chance than the one with habits and structure highly specialized for certain peculiar conditions. To this fact is due the existence of the opossum at the

present time. The Marsupial type of mammal is the most primitive and the opossum as a race has existed for epochs, while one after another of the more specialized groups of mammals have become decadent or entirely disappeared.

Even now, when he has come into contact with civilized man, the opossum is holding his own very well. In some parts of Indiana the species is not so numerous as it once was, but it is still very generally distributed and even lives in the outskirts of towns and cities.

Its den may be in a deserted woodchuck hole, a hollow log or tree, a natural cavern, a sewer or any other conceivable place that will afford shelter. There, in a rude nest of dried grass, the young are born. The usual number of a litter is from six to ten, but it is said that as many as sixteen are sometimes produced. There are two or three litters in a season.

The young are less than an inch long when born and are blind and naked with imperfectly developed limbs and organs. The mother at once thrusts them into the pouch on her abdomen. They secure hold of the teats and the lips grow about them, so that the young cannot be removed without tearing the mouth. At this stage they are entirely helpless and do not even suckle, the milk being forced into their mouths by the contraction of special muscles about the mammary glands of the mother. They remain in the pouch for some weeks and attain a length of four or five inches before they leave it. For some time longer they remain with the mother and a second litter may be born and placed in the pouch while the first is still running about her back and clinging to her tail.

Most people know something about the peculiar manner in which the young opossums are nurtured, but there are many fables and wrong ideas on the subject. A few years ago the author saw a letter written to the Smithsonian Institution by a Virginia gentleman who claimed to have been a student of natural history for forty years. He asserted that our ideas of the breeding habits of these animals are all wrong and that "the young grow out from the abdomen of the mother like cherries on a stem." The writer also has a letter before him from one of the pioneers of this State, asserting that gestation takes place in the pouch of the mother and that there is some direct connection between this pouch and the internal reproductive organs. It is needless to say that both ideas are preposterous. The early stages of the reproductive process differ in no essential way from those of domestic cattle, rabbits or other mammals.

The opossum is not at all particular as to food. Persimmons and apples are staple articles of diet in the fall, where they can be obtained. Other fruits are also eaten. Insects, crayfish, mollusks, salamanders, frogs, small birds and mice are all eaten with apparently equal relish. Refuse of various kinds, carrion and fresh meat are also eaten.

Mr. E. J. Chansler has given me an account which illustrates both their feeding habits and numbers in Knox County half a century ago. He says: "In 1859 my father killed hogs one day and that evening he killed eight opossums in the dooryard before bed time. They were attracted by the blood and offal."

These animals are not as numerous in southern Indiana now as then, but are in no danger of extermination. In the Kankakee Valley they are said to have increased in numbers in recent years.

Professor Van Gorder states that opossums were plentiful in Noble County previous to the winter of 1854-55. The severe weather of that winter exterminated them and he knows of no further records until 1900. Since that time they have again become plentiful, so much so that they are frequently seen on the car tracks of an interurban line and three were killed by a single car during the winter of 1907-8.

While they occasionally do some damage by killing poultry and useful wild birds, they do more good by destroying harmful insects and mice. The flesh is eaten with great relish by most negroes and many whites, although it is very fat and oily. The skins find a ready sale at from 15 to 25 cents apiece, and are frequently seen made into ladies' furs.

Order UNGULATA.

HOOFED ANIMALS.

Animals which have the feet terminating in rounded hoofs and the heels much elevated above the toes so that only the tips of the latter are placed on the ground in walking. The molar teeth have broad flat crowns and the digestive tube is usually long and complex, being adapted to a vegetable diet.

The ungulates are nearly all animals of medium or large size and are of great economic value. The domestic animals such as swine, sheep, cattle and horses are all included in this group. They are creatures that, in the process of evolution, have found it advantageous to escape their enemies by flight rather than by cunning

or by resistance. Hence the bones of the limbs are elongated, giving the animals a longer stride, and the tips of the toes are encased in hoofs which afford protection and a solid footing.

Family BOVIDAE.

CATTLE, SHEEP, ETC.

Animals with hollow horns which are never shed; no canine or upper incisor teeth; two functional hoofs on each foot and usually two lateral hoofs which do not reach the ground; stomach with four divisions.

Genus BISON Hamilton Smith.

Dental Formula.—I, $\frac{0-0}{4-4}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{3-3}{3-3}$; M, $\frac{3-3}{3-3}=32$.

Body covered with crisp woolly hair, longer on the head and shoulders and forming a mane which reaches down on the forehead. Horns and hoofs black; height greatest at the shoulder.

2. BISON BISON (Linnaeus).

AMERICAN BISON; BUFFALO.

Bos bison Linnaeus, Syst. Nat. 10th Ed., I, p. 72, 1758.

Bison bison Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 135, 1894.

Description and habits.—The bison, or buffalo as it is generally but incorrectly called, is too well known from pictures and descriptions to require an elaborate diagnosis here. It has not lived in Indiana in a wild state for nearly a century but must be counted with our indigenous mammals that have disappeared before advancing civilization. Two species formerly existed in immense numbers in North America. The eastern form differs from the woodland bison of western Canada in its paler color, smaller size and shorter horns.

In the early days bison were numerous in Indiana on all of the prairies, meadows and in the more open woods. Their range did not extend much beyond the northern boundaries of the State, but doubtless included all of the northern counties.

Concerning the numbers of bison formerly existing in the Ohio Valley, Mr. Hornaday quotes from several early travelers as follows: "The amazing herds of buffaloes which resort thither [to the salt licks in Kentucky] by their size and number fill the traveler with amazement and terror, especially when he beholds the prodigious roads they have made from all quarters—the vast space of land

around these springs, desolated as by a ravaging enemy and the hills reduced to plains by the pawing of their feet. I have heard a hunter assert he saw above one thousand buffaloes at Blue Licks at once.'' Lewis and Clark estimated that they saw twelve thousand at one time in South Dakota, and Colonel Dodge estimated that he saw half a million during a day's ride on the western plains.

In Indiana they were not so numerous as west of the Mississippi but were doubtless as abundant as in Kentucky. Indeed, there seems to have been a regular migration from the prairies of the West across Indiana, to the salt licks and blue grass meadows of Kentucky. One of their trails crossed the Wabash River nine miles south of Vincennes.

The year in which wild bison were last seen in the State is uncertain. Hornaday places the date of their disappearance at 1810, but this is possibly a few years too early. The Prince of Wied, who spent the winter of 1832-33 at New Harmony, states that they were still abundant on the Illinois prairies a few days' journey from there. Mr. E. J. Chansler informs me that a Mr. Thompson, who made the brick for Governor Harrison's mansion at Vincennes, saw buffalo near there in 1808. Mr. Chansler says also that the father of John G. Bailey came to Vincennes in 1800, when the son was six years old and that the latter could have killed buffalo just east of the town after he became old enough to hunt. This would place the date of their disappearance from the vicinity as late as 1808 or 1810. At that date the upper Wabash Valley and the prairies beyond had scarcely been settled at all and it is reasonable to suppose that bison existed there somewhat later than in the vicinity of the earliest settlements.

However, these magnificent game animals disappeared very shortly after the coming of the white settlers and long before the country became thickly settled. Many of the animals, even in that early day, were wantonly slaughtered for their hides. But the fact that immense herds migrated between the western prairies and the licks of Kentucky and southern Indiana is one reason for thinking that they may have been driven out of this State rather than entirely killed off. Whatever the exact fate of the bisons of Indiana, the almost complete extermination of the race must always be looked upon with regret.

However, from a biological standpoint, nothing but their destruction could have been expected. Although not usually placed very high in the scale among mammalian animals, the bison was in a way, highly specialized. The large size of the animals, their gre-

garious habits and the herbivorous nature of their food, all combined to render them independent of the biological environment. Wolves and cougars killed an occasional stray calf or sick adult, but they were without formidable enemies. Food was always at hand, and neither skill nor cunning was required to procure it; or if it failed because of drouth or fire, skill and cunning were of no avail. Consequently the habits of the animals became fixed; their mental capacity was not well developed and they were unable to cope with enemies.

Then white men came on the scene and the balance of nature was upset. It is, of course true, that nature has never evolved an animal capable of competing with gunpowder and rifle. However, the gregarious habits and comparative fearlessness of the bison rendered them especially easy victims and made it possible to destroy them by the hundreds and thousands.

Family CERVIDAE.

DEER.

The deer are ungulates with solid, usually branched antlers which are shed and renewed each year; these usually are present in the male only; no incisor teeth in the upper jaw but upper canines often present; stomach with four divisions as in other ruminant animals.

Genus CERVUS Linnaeus.

Dental Formula.—I, $\frac{0-0}{4-4}$; C, $\frac{1-1}{0-0}$; Pm, $\frac{3-3}{3-3}$; M, $\frac{3-3}{3-3} = 34$.

Size large, standing four and a half to five feet at the shoulder; antlers, four and a half to five feet long, directed outward and backward but with the tines all directed forward.

This genus is represented by one species, now exterminated or nearly so, in eastern North America, several closely allied species in the west and a few others in Europe and Asia. All are deer of large size.

CERVUS CANADENSIS (Erxleben).

AMERICAN ELK; WAPITI.

Cervus claphus canadensis Erxleben, Syst. Regn. Animal, Vol. I, p. 305, 1777.

Cervus canadensis Desmarest, Mammalogie, Vol. 2, p. 433, 1822. Butler and Evermann, Proc. Ind. Acad. Sci. for 1893, p. 135, 1894.

Diagnostic characters.—Distinguished from other members of the deer family by its large size and long, branching antlers.

Description.—Color yellowish brown, darker on the under side and legs; buttocks yellowish white. The antlers project backward and outward and their tines point forward and upward. Height of bull elk at shoulder, about five feet. Antlers sometimes five feet in length. The female is smaller and paler colored.

Range.—Formerly abundant in eastern Canada and the United States, as far south, at least, as Tennessee; westwardly it probably extended to the Rocky Mountains; farther west are other closely related species of elk. The eastern form has not a single living representative and but one preserved skin is known to exist. That one is preserved in the Academy of Natural Sciences of Philadelphia.

Records for Indiana are meagre. Dr. John T. Plummer says that the last elk was killed near Richmond in 1811. Evermann and Butler say that it was found in Ripley County subsequent to 1810. E. J. Chansler, on the authority of Mr. Brad Thompson of Bruceville, Knox County, states that an elk was seen near that place in 1830. Mr. Chansler also says that one was killed on Pond Creek, Knox County, by G. T. Everbaugh in 1829. Another man is quoted by Mr. Chansler as saying that an elk was seen in Knox County in 1850. The last record is certainly erroneous or relates to a captive animal.

The records given above for 1829 and 1830 are probably reliable and are the latest ones of which I have any knowledge. Wied says that they were already gone in 1832-3. Many of the local histories I have examined speak of bear, deer and other game in the period from 1820 to 1836, but do not mention elk at all, and they must have been very rare even at this period, although in Pennsylvania the last elk was not killed until 1867 (Rhoads, 1903, p. 30).

Chansler tells me of the abundance of elk horns in Daviess and Knox counties in early years, and Rev. T. H. Ball, in the history of Lake County, states that elk antlers were found in Cedar Lake in that county. In the history of Dearborn and Ohio counties it is stated that Ben Moulton found an elk's head on Laughery Creek so large that when the tips of the antlers were placed on the ground Moulton stood between them without touching the head. There are pieces of elk antler in the State Museum from Jasper and Newton counties. I know of no other records, although in the early days the species was doubtless plentiful in all parts of the State. Usually it prefers wooded and rough country and we may therefore suppose that it was more abundant in the wooded hills of the southern part of the State than in the prairies of the northern portion.

Habits.—The following account is drawn chiefly from the writ-

ings of President Roosevelt and Judge John D. Caton. Elk, or wapiti, as they are more correctly called, are the most gregarious of the deer family. During the early summer the mature animals lead a somewhat solitary existence, the cows hiding away to rear their calves and the old bulls living quietly in obscure retreats while their antlers are in velvet. But in late summer they collect in bands. Each old bull has his harem of females which he guards jealously. If another bull approaches they engage in deadly combat, backing off and rushing at each other or locking antlers and struggling with all their might. Sometimes the antlers become locked inextricably and both animals perish. More frequently, one vanquishes the other. As long as he gives fight the weaker bull's danger is not great for the thick skin of the neck is scarcely penetrated by the sharpest thrust of the great antlers, but if he turns to flee and is gored in the flank, a serious wound is inflicted and often causes death.

Frequently a number of small bands group together, each one under the leadership of its master bull. However, each retains his own harem intact and jealously guarded.

There is no semblance of gallantry among these lords of the tribe. A bull will often fight desperately when attacked but he fights for himself only. If his mates and young are endangered when he has a chance to escape, the old bull makes no attempt to defend them, but seeks safety in flight. Nor does he hesitate to drive the females and young from any choice bit of food they may have found, and appropriate it to himself.

Practically all kinds of vegetable food are eaten with equal relish. Weeds, grass and rushes, as well as twigs, bark and leaves, are all acceptable. It is said that in winter they will thrive on food coarser than that on which either deer or domestic cattle can exist.

The mating season is in September. The young are born in May. In the first one or two seasons, but one young is produced. Cows in their prime usually give birth to two, rarely three, calves each year.

The young are spotted, like young deer. The first autumn they lose their spotted coat, becoming uniformly colored but paler than the adults. About eight years are required to reach full maturity, though they breed the second or third year. An adult bull sometimes attains a weight of twelve or fifteen hundred pounds.

The most remarkable thing about the wapiti, and other members of the deer family, is the rapid growth of the antlers. These begin

to grow about April and have on the outside, a growth of cutis covered with short hairs and filled with blood vessels. By August the antlers of a bull in his prime may reach a length of five feet each. At this time the velvet becomes dead and is rubbed off by thrashing against trees. During the fall and winter the antlers are bare and in late winter they are shed, coming off at a rounded knob called the "burr," near the base. Males of the second summer have straight unbranched antlers. A tine is added each year until there are six, though some may be deformed or lacking.

Next to the bison, the elk disappeared more rapidly before civilization thany any of our game animals. The causes of extermination are practically the same for both animals. Their great size rendered them noteworthy objects of the chase. Their gregarious habits made it easy to kill large numbers when a herd was located, and the early settlers had no thought of preserving the game which was then so abundant. Added to this was a certain sort of stupidity which often allowed them to stand fearlessly while the entire herd was shot down. They are also less nocturnal than other deer and while preferring rough ground, they do not hide away in dense thickets as the Virginia deer does.

Genus Odocoileus Rafinesque.

Dental Formula.—I, $\frac{0-0}{4-4}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{3-3}{3-3}$; M, $\frac{3-3}{3-3} = 32$.

Generic characters.—Antlers, always less than thirty inches in length; the tips curved forward and inward and the tines directed upward; first tine some distance above the base.

This genus is confined to North America. One species with several geographic races is found east of the Mississippi. To the west there are other species.

ODOCOILEUS VIRGINIANUS (Boddaert).

VIRGINIA DEER.

Cervus virginianus Boddaert, Elenchus Animalum, p. 136, 1784.

Cervus dama americanus Erxleben, Syst. Regn. Animal, Vol. I, p. 312, 1777.

Cariacus virginianus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 135, 1894.

Odocoileus americanus Miller and Rehn, Proc. Bost. Soc. Nat. Hist., vol. 30, p. 14, 1901.

Odocoileus virginianus Merriam, Proc. Biol. Soc., Washington, Vol. 12, p. 100, 1898.

Diagnostic characters.—Size comparatively small; antlers curving first outward and back, with the tips turned forward and toward each other; not diverging into equal branches.

Description.—Color of adults reddish brown above in summer; belly, inner side of legs and under part and tip of tail, white; chin with a black band; in winter grayish above. Young, spotted with white. Skull and teeth comparatively small and antlers slender.

Range.—Formerly abundant from the region of the Great Lakes, central New York and New England, to Florida and Louisiana, and from the Atlantic west to Kansas. Slightly different geographic races are found beyond the limits outlined above.

In Indiana deer were once so abundant as to be a nuisance, and the pioneer farmers were often compelled to kill them to protect their crops. It is said that they used to mingle with the domestic cattle that were turned out to graze and learned to come to them on hearing he sound of their bells.

Judge D. D. Banta, in the history of Johnson County, tells us that one of the early settlers, Joab Woodruff, killed 370 deer in the fall of 1822. As late as 1834 a herd was chased from near Franklin, over what is now part of Indianapolis and back into Johnson County, where six were killed.: In the early forties a grand drive for wolves and deer in Warren County resulted in killing 160 deer, while an equal number escaped. (History of Warren County.)

It is difficult to determine the time at which deer disappeared from the different sections of the State, but they were everywhere the last of the large game to be exterminated. Butler states that they were still found in Ripley County "only a few years ago" (written in 1893). According to W. J. Ward, a drove of three were seen and two of them killed in the Eel River bottoms in the latter 50's. In Lagrange County the last one was killed in 1859 (Theo F. Upson). Dr. Haymond, in 1869, doubts whether there is a single deer in Franklin County. In Warrick County the last wild deer was killed in 1874 (Bob White). In the History of Allen County, edited by T. B. Helm, it is stated that some are still (1880) to be found in a large marsh in Jackson township in that county. In Wabash County they were still abundant in 1854 (County history, by T. B. Helm). In Steuben County they have not been seen since about 1865. In Noble County they disappeared between 1853 and 1867 (Van Gorder). The swamps of the Kankakee Valley and the cypress swamps in Knox County were the last retreats of the deer in this State. According to Butler (1894) one was killed in Jasper County in 1890 and one was seen in Newton County in 1891. The

author spent a month collecting in the Kankakee Valley in 1905 and could learn of no records for that part of the State more recent than those given above.

Chansler states, on the authority of Mr. N. B. Edwards, that the last wild deer were seen near Red Cloud in Knox County in 1893. The writer was told by several Knox County citizens, whose names he does not now remember, that deer were seen in the cypress swamps in the southeastern part of that county as recently as 1906. However, these were probably animals that had escaped from a private deer park owned by Mr. Thomas Johnson near Decker. They had disappeared over most of the State much earlier. Several accounts say that they were diminishing in numbers, though still common, in the period from 1830 to 1840. By the latter date they were doubtless becoming rare in many places and were exterminated in most of the counties previous to 1860.

Habits.—The ability of deer to exist in places where bison and elk have long ago been exterminated by man, is due chiefly to their retiring habits. Where deer are hunted much they hide away in the most inaccessible mountain retreats, the densest thickets or the most impenetrable swamps. In such places they rest during the day and are active only at night.

Where they are afforded adequate protection from hunters, as in New York, New England and some other States, they become more tame and rapidly increase in numbers. In Maine it is said that they have again become numerous where they were once all but exterminated. Reasonable protection, together with setting aside forest and swamp land for permanent reservations, would have produced the same result in Indiana.

The mating season is in the fall, from late October to about the first of December. The males at this time lose their timidity and come out in the open. At this season they do not hesitate to attack a man on slight provocation.

The young are born in late April, May or June. Usually there are two, and the mother seeks the most secluded retreat for their birth-place. For several weeks they are quite weak and do not travel far, but by the middle of summer they become strong and active. The first coat is spotted. The second summer the males or "spike bucks" are equipped with straight, unbranched antlers which grow rapidly and are shed at the end of the season like those of the wapiti. The second year there are two prongs and another is added each year until maturity.

The Virginia deer can subsist in winter on such coarse feed as

twigs and dead leaves, or on beechnuts and acorns which they dig out of the snow. In summer, when food is plentiful, they prefer the succulent grasses of the lowlands, and also frequent ponds, where they eat the aquatic vegetation.

Order GLIRES.

GNAWING ANIMALS.

Characters of the order.—Lower incisors, 2; upper incisors, 2 or 4, chisel shaped and adapted for gnawing, growing throughout life from persistent pulps; canines lacking; a fold of skin turned inward at the sides of the jaws and separating the mouth into two divisions.

The animals belonging to this order are all of small size. Dr. Coues says of them: "Though a feeble folk, comparatively insignificant in size and strength, they hold their own in legions against a host of natural enemies, rapacious beasts and birds, by their fecundity, their wariness and cunning, their timidity and agility, and their secretiveness, each after the means by which it is provided for exercising its instinct of self-preservation, among which insignificance itself is no small factor."

Family SCIURIDAE.

SQUIRRELS.

Upper incisors two; molars three on each side of upper and lower jaws; premolars one or two on each side above and two below; frontal bone with a post orbital process. Tail long and hairy, very often bushy. Toes four on the front foot and five on the hind foot.

Squirrels are medium sized rodents with generally arboreal or fossorial habits. They are found in all parts of the world except Australia. The family contains many genera and there are more species belonging to it than to any other family of mammals excepting rats and mice (*Muridae*).

Genus SCIURUS Linnaeus.

Sciurus Linnaeus, Syst. Nat., ed. 10, Vol. I, p. 63, 1758.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{1-1 \text{ or } 2-2}{1-1}$; M, $\frac{3-3}{3-3} = 20$ or 22.

Generic characters.—Tail long and bushy. Ears well developed, pointed, hairy. Feet adapted for climbing.

The distribution of the genus is nearly the same as that of the family. The species are very numerous, especially in the tropics. The forms found in Indiana may be distinguished by the following key:

Size small; length from nose to tip of tail under 375 mm. (15 in.); hind foot under 50 mm. (2 in.). (Subgenus *Tamiasciurus.*) *Sciurus hudsonicus loquax,* p. 468.

Size large; total length over 450 mm. (18 in.); belly and ears always more or less rusty; upper cheek teeth, 4 on each side. (Subgenus *Parasciurus.*) *Sciurus niger rufiventer,* p. 466.

Belly and ears whitish; upper cheek teeth, 5 on each side. (Subgenus *Neosciurus.*) Back always somewhat rusty; hind foot about 60 mm. (2⅜ in.). *Sciurus carolinensis,* p. 461.

Back gray in winter; body heavier; hind foot about 70 mm. (2¾ in.). *S. c. leucotis,* p. 464.

SCIURUS CAROLINENSIS Gmelin.

SOUTHERN GRAY SQUIRREL.

Sciurus carolinensis Gmel., Syst. Nat., Vol. I, p. 148, 1788.

Sciurus carolinensis carolinensis Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 130, 1894.

Bangs, Proc. Biol. Soc., Wash., Vol. 10, p. 153, 1896.

Diagnostic characters.—Size smaller than either the northern gray squirrel or the fox squirrel, but much larger than the red squirrel; back grayish and belly white, both having a rusty tinge.

Description.—The southern form of the gray squirrel differs from the closely related northern subspecies chiefly in its smaller size and in the rusty tinge of the fur in winter; in the northern form the back and ears are clear gray in winter. The dimorphic black phase is seldom found in this smaller southern race.

Measurements.—The skin of a single individual from Bloomington measures: head and body, 250 mm. (10 in.); hind foot, 62 mm. (2½ in.).

Skull and teeth.—Skull slightly smaller than that of the fox squirrel, with a narrow, compressed rostrum, long nasals and broad braincase. There are two premolars above (5 cheek teeth on each side in the upper jaw) while the fox squirrels have but one premolar in each side of the upper jaw.

Range.—The two subspecies of the gray squirrel are not sharply marked off in Indiana. I should be inclined to call most of those from the southern half of the State, *carolinensis.* At Bloomington

and Mitchell, the characteristic rusty tinge is generally retained in winter, although individuals are sometimes seen in which the back is nearly clear gray. I have seen but few winter specimens from farther north than Indianapolis. McAtee (Proc. Biol. Soc., Wash., Vol. 20, p. 3) records *leucotis* from Bloomington but on the other hand Bangs assigns specimens from Denver, Miami County, to the southern form. The gray winter coat and the larger size, places those from the two northern rows of counties at least, in the subspecies *leucotis*, althought they cannot be regarded typical. Throughout the central part of the State there is a blending of the two forms. Some individuals from the same locality have the characteristics of one variety and some of the other, while other individuals cannot be definitely assigned to either race.

The southern form ranges from central Indiana and Iowa east to the atlantic and south to the Gulf States. Different varieties occur in Florida and Louisiana.

Habits.—The gray squirrel is characteristically a dweller of the deep forest. The giant white oaks, tulip poplars, red maples and shellbark hickories which covered the hills of southern Indiana in the early days were its delight. Yet, where it is protected and fed, it becomes a contented inhabitant of city parks and shade trees.

It is diffcult for the present generation to realize how numerous these animals were in the early days. Judge Banta, in the history of Johnson County, states that in 1821 four families living in White River township, did not succeed in saving a single bushel of corn from the squirrels. In a four acre field of shocked corn, only a single ear was overlooked by the squirrels. In another four-acre field every ear was taken within two days after the corn had ripened.

The historian of Bartholomew County gives an account of a great squirrel hunt which took place in that county in 1834. There was strong rivalry between Sand Creek and Wayne townships as to which had the best squirrel hunters. Finally it was agreed that each township should select fifty men to compete in a three days' squirrel hunt, to be terminated by a great barbecue for which the losing side was to pay. The total number of squirrels killed is not recorded, but an idea of the destruction of the animals may be obtained from the statement that the individual championship was awarded for killing 900 squirrels in three days. The second largest number was 783.

In the early days the fox squirrels were much less numerous than the gray species. Now the latter are exterminated in many

places and those remaining are generally limited to the larger tracts of woodland while the fox squirrels are still common in most of the open groves.

The gray squirrel has also been called the migratory squirrel on account of the habit the species formerly had of making long marches or migrations at irregular intervals. At such times they gathered in droves of thousands and began to move in one direction. Audubon thus describes one of these migrations: "It was in 1813 when we were descending the Ohio River in a flatboat, chiefly with the intention of seeking for birds then unknown to us. About one hundred miles below Cincinnati, as we were floating down the stream, we observed a large number of squirrels swimming across the river and we continued to see them at various places until we had nearly reached Smithland, about one hundred miles above the mouth of the Ohio. At times they were strewn, as it were, over the surface of the water, and some of them being fatigued, sought a few moments rest on our long steering oar which hung in the water in a slanting direction over the stern of our boat."

In Wabash County there was a great northward migration of the squirrels in 1834, when they swam the Wabash River in countless numbers. Mr. E. J. Chansler states on the authority of several old settlers, that the squirrels also migrated in Knox County in 1834, and again in 1836 and 1837.

On the occasion of these migrations the pioneer farmers resorted to various means to get rid of the pests and save their corn. The children were stationed in the fields with bells, tin pans and horse fiddles to frighten them away. Hundreds were drowned while crossing streams and many were shot by the unerring marksmen of those days. A local historian tells of one man who shot 26 without moving from his tracks.

The species is very prolific and even this wholesale slaughter would scarcely have held the number in check had it not been accompanied by clearing the forest and so reducing the available habitat of the squirrels. Two litters are usually reared each year. The first is born just at the end of winter, usually during the first two weeks of March, in southern Indiana. The parents mate again shortly afterward and the second litter is born any time from July to September. I have seen the young, only just large enough to leave the nest, on the seventh of the latter month. Very young squirrels may also be found at times throughout the summer, but it is probable that they are the offspring of the last litter of the previous year.

Economic status.—Under present conditions, gray squirrels rarely do much damage to fields of corn and, as far as I know, are never injurious in any other way. They are pretty and interesting animals and every effort should be made to give them protection and preserve the species from extermination. When kept in groves or city parks they should be provided with rain-proof boxes, as they are very liable to pulmonary diseases during the early spring months. In the Smithsonian grounds at Washington, D. C., not less than six, of a colony of 15 or 20, died during the spring of 1905, and in each case the cause of death was pronounced by the government veterinarians to be pulmonary diseases.

SCIURUS CAROLINENSIS LEUCOTIS Gapper.

NORTHERN GRAY SQUIRREL.

Sciurus leucotis Gapper, Zool. Journ., Vol. 5, p. 206, 1830.

Sciurus carolinensis leucotis Miller and Rehn, Syst. Results of the Study of N. Amer. Land Mam. to 1900, p. 31, 1901.

Sciurus carolinensis hypophaeus Merriam, Science, N. Ser., Vol. 7, p. 351, 1886.

Diagnostic characters.—Size larger than the southern gray squirrel, the average length being about 19 inches as against 17 for the southern; the hind foot of the northern form is 2½ inches while that of the southern is 2⅜ inches. Ears and back clear gray in winter without a rusty tinge.

Description.—Except for the characters given above, the subspecies *leucotis* resembles the typical *carolinensis.*

Measurements.—Five specimens from the Kankakee Valley south of Hebron average: Total length, 473 mm. (19 in.); tail, 223 mm. (9 in.); hind foot 62.5 mm. (2½ in.). Typical specimens from southeastern Canada are somewhat larger.

Range.—The principal facts known concerning the range of the two forms in Indiana are stated under the account of *carolinensis.* In the Kankakee Valley in Porter and Jasper counties I have found that the gray squirrel usually keeps in the denser swamps and is seen less frequently than is the fox squirrel, although equally abundant.

Van Gorder thinks the species is extinct in Noble County and Upson states that he has not seen the black phase in Lagrange County since 1879 and that the gray squirrels are also nearly extinct. It should be remarked that most species of animals are regarded as less numerous than they really are because they are not frequently seen.

Remarks.—One of the chief points of interest in connection with this subspecies is the status of the dimorphic black phase. Where the two forms occur, the black phase is always considered a distinct species in the popular mind. The early American naturalists held the same view, but Baird correctly placed the two color varieties in the same species in his account of the mammals of North America, published as a volume of the Pacific Railroad reports in 1857.

Almost thirty years later Merriam described a subspecies from Elk River, Minnesota, as *Sciurus carolinensis hypophaeus,* the principal characters being a dusky belly associated with the typical gray coat of *S. c. leucotis.* While collecting along the Kankakee in Porter County in 1905, the writer obtained a series of squirrel skins which show gradations from the light grizzled back and white belly of *leucotis* to the grizzled back and dark belly of *hypophaeus,* and the almost complete black of the dark phase. Some of the specimens have the ordinary gray back and at the other extreme the squirrels appear to be entirely black unless closely examined, when paler rings can be distinguished on some of the hairs.

These and similar facts obtained by other collectors clearly indicate that both the dark bellied and black varieties are forms which may be produced by the common gray squirrel at any time or place for causes as yet wholly unknown. Since they probably do not breed true they cannot be considered as true species or subspecies.

It is of interest to know that the black phase was formerly more abundant in some parts of southern Indiana than they now are. Dr. Haymond wrote in 1869: "The black squirrels were common—forming about one-third of the total number of squirrels in southeastern Indiana at the period of its first settlement. Now they have completely disappeared."

At New Harmony, however, Wied states that Lesueur saw but one black squirrel in many years. The writer has not seen or heard of a black squirrel in the southern part of the State in recent years. In other states, also, it has been found that the black squirrels are the first to disappear. This is no doubt due, in part, to the fact that they are more conspicuous and are therefor killed off the more quickly. It is possible, also, that they are, in a way, abnormal and lack the vitality necessary to continue their kind under adverse circumstances. In southern Porter and northern Jasper counties in 1905 the black or partially black squirrels were nearly as numerous as the gray.

SCIURUS NIGER RUFIVENTER (Geoffrey).

FOX SQUIRREL.

Sciurus rufiventer Geoff., Cat. Mus. Hist. Nat. de Paris, p. 176, 1803. Allen, Bull. Am. Mus. Nat. Hist., Vol 16, p. 167, 1902.

Sciurus niger ludovicianus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 131.

Sciurus niger rufiventer Osgood, Proc. Biol. Soc., Wash., Vol. 20, p. 44, 1907.

Diagnostic characters.—Size larger than any of the gray squirrels; hair of back banded with gray and rusty yellowish; tail very long and bushy; under parts bright, rusty yellow.

Detailed description.—The rusty or "foxy" color of this species separates it readily from the gray squirrels and it is never confused with them. The muzzle is usually bordered with the yellowish color which also encircles the eyes. The hairs of the back are colored with alternate bands of blackish and rusty. Hairs of belly are blackish at base but rusty yellow on the outer third and this color also predominates on the under side of the tail. The exact shade of the yellowish color is extremely variable in different individuals as is also the proportion of yellow and black. Hence the great differences in the appearances of the animals.

Measurements.—The average of five specimens from northwestern Indiana is: total length, 547 mm. (21⅞ in.); tail, 245 mm. (9⅞ in.); hind foot, 67 mm. (2 11/16 in.).

Skull and teeth.—The skull is long with a narrow braincase and relatively broad rostrum. It differs from the skull of the gray squirrel also in that it lacks the small first premolar, there being but four cheek teeth on each side of the upper jaw.

Range.—Fox squirrels belonging to four or more subspecies are found throughout the region from the western border of the great plains to the Atlantic. The subspecies, as now recognized, has a range extending from South Dakota and Wisconsin to the Alleghenies and south to Mississippi. However, the squirrels from the western part of this range differ from their eastern relatives as much as these do from some of the other forms.

In Indiana the fox squirrel is found throughout the State wherever sufficient timber remains to afford shelter.

Remarks.—The fox squirrel does not have a black phase, and melanistic individuals are rare if they ever occur, although the southern form *Sciurus niger* is black with white ears and nose.

However, white or partially albinistic individuals are not uncommon. Bangs* mentions a "curious series representing every degree of albinism," from Denver, Miami County, Indiana. I have records of albinistic individuals from Kouts, Porter County, and Rising Sun, Ohio County, and there is a skin in the Indiana University collection at Bloomington.

Habits.—The fox squirrel seems better able to adapt itself to man's proximity than its gray cousin. The actual number in the State has no doubt decreased as the land has been subjected to tillage, and the numbers are probably still decreasing, but this is due to the vanishing forests rather than to actual extermination. However, they are not disappearing as rapidly as the gray squirrels. In the early days the latter species outnumbered the fox squirrels. Indeed, Dr. Haymond says they first appeared in Franklin County about 1837, but his statement is open to question, as Dr. Plummer records it without comment at Richmond in 1844, and the Prince of Wied says that it was common at New Harmony in 1832, although less abundant than the gray species.

It is difficult to say just what has enabled the squirrel of this species to cope better with man than its smaller relative. Its food is similar for the most part, as is its method of obtaining it. The fox squirrel often lives in the open groves about farm buildings, whereas the other species does not often voluntarily take up its residence outside of large tracts of tall timber. In the winter of 1906-7 but one fox squirrel was known to live on the 180-acre tract of large trees on University Farm near Mitchell. Large numbers of gray squirrels inhabited this tract. But in the open wood lots of the surrounding farms fox squirrels were abundant, while the other species was rare.

According to some statements, fox squirrels sometimes joined their gray kindred in the great migrations of the early days. They were in the minority, however, and the early writers always mean the gray species when they speak of the migratory squirrel. At the present time the fox squirrel seems to wander the most, although it is not known to take long journeys. In their wanderings from one wood to another they are often chased up a solitary tree in a field and become victims of the farmer's dog or gun. When hard pressed by a dog they do not hesitate to enter a sinkhole or underground burrow.

Like the gray squirrels, this species stores up quantities of

* Proc. Biol. Soc. Washington, Vol. 10, p. 146.

acorns and nuts in hollow trees and depends partially on these stores for the winter supply of food. In the summer they feed to a large extent on tender roots, bulbs and berries. I have found their stomachs nearly full of blackberries. They begin quite early to eat the unripe nuts and acorns and their lips are sometimes much stained by the juices of acorns as early as August 20.

So far as I am aware, the breeding habits of this species do not differ greatly from those of the gray squirrel. Two litters are produced a year.

SCIURUS HUDSONICUS LOQUAX Bangs.

RED SQUIRREL; PINE SQUIRREL; CHICKAREE.

Sciurus hudsonicus loquax Bangs, Proc. Biol. Soc. Washington, Vol. 10, p. 161.

Sciurus hudsonicus Evermann and Butler, Proc. Ind. Acad. Sci., for 1893, p. 130.

Diagnostic characters.—Size much smaller than the other tree squirrels; sides with a black stripe in summer; back with a broad rusty band down the middle; and ears with tufts of long hair in winter.

Description.—In winter the back is a bright, deep rusty red in the middle and grayer or more olivaceous on the sides; the hairs all ringed with black. The belly is white with the dark plumbeous at the base of the hairs, sometimes showing through. The central part of the tail is the same color as the middle of the back. Outside of this reddish color there is a band of black followed by a band of lighter red at the tips of the hairs. In summer the red band in the middle of the back is not so distinct and there is a distinct blackish line along the flanks. The ears in winter have a distinct tuft of long hairs which are not present in summer.

Measurements.—An adult female from Porter County measured in total length, 322 mm. (13 in.); tail, 141 mm. (5 11/16 in.); hind foot, 43 mm. (1 12/16 in.).

Skull and teeth.—The skull (fig. 4) is readily distinguished from that of the other tree squirrels by its small size. Compared with that of the ground squirrels it has a short, broad rostrum and braincase. There are two premolars on each side of the upper jaw (five cheek teeth) but the first one is always small and occasionally it is lacking.

Range.—This subspecies of the red squirrel has a range extending from northwestern Indiana to southern New England and south in the mountains to the Carolinas. Other forms are

found in northern New England, Labrador, Minnesota and to the west.

In Indiana its range includes the northern part of the State only, and there are localities within its range where it is wholly unknown. I was unable to hear of it near Roselawn in northern Newton County. In southern Porter County, 30 miles east of Roselawn, it was abundant in a country that does not differ in the character of the soil, drainage or timber.

Other localities are Laporte, South Bend, Kewanna, Ray, Winona Lake, Marion and Miami, Fulton, Wabash, Randolph, Lagrange, Huntington and Delaware counties, Dr. Haymond reported in 1869 that one had been seen in Franklin County, but there is no other record as far south.

a b

FIG. 4.—Skull of *Sciurus hudsonicus loquax*: a, lateral view; b, dorsal view. After Baird.

Habits.—In this State the red squirrels seem to prefer the open groves near barns and farm residences. In South Bend they have taken up their residence in the catalpa trees that border one of the streets well within city limits. Here they are known to be guilty of robbing birds' nests. There is a colony of red squirrels in the grounds of the Winona Assembly at Winona Lake.

The writer's personal acquaintance with this species in its native haunts is somewhat limited. It is an active, energetic animal, apparently spending most of its time in searching for, storing up and eating food. Much of its time is spent on the ground, where it gathers acorns and nuts and buries them under the leaves and soil. Some supplies are stored in hollow trees also, although the snow is no hindrance to its finding and securing buried treasure.

In summer it usually has a home built of sticks in the branches of the trees and sometimes this is built tightly and firmly enough

to afford a winter home also. However, a hollow tree is generally utilized for this, and sometimes the creatures have a hole under a stump or rock to which they also resort.

Stone and Cram say of the red squirrel that "he has more petty vices and fewer virtues than any other beast that roams the woods. He is quarrelsome, noisy and forever prying into the affairs of others. In winter he makes a regular business of robbing his neighbors of the stores of provisions they have gathered, though he always has more than his share hidden away at home and zealously guarded; and in summer he robs birds' nests high and low.

"Yet one cannot help liking him, for a keen sense of humor and never-failing good spirits tip the balance against all sorts of evil deeds. Even in northern New England the cold is never fierce enough to curb his jollity any more than the blistering heat of July. * * *

"Few people realize what thoroughly practical, thrifty and ingenious little animals they are, for, unlike most thieves, they are not in any way shiftless or lazy, but are steady, hard workers the year round. There is no idle season for them.

"Other squirrels live a careless, gypsy sort of life through warm weather, commencing the labor of harvesting only when the nuts are ripe. But as early as July, while the young squirrels have still to be watched over and looked after, the industrious red squirrels begin cutting off the green cones of the white pine, and work early and late burying them, half a dozen in a place, under pine needles, to be dug up in the winter and early spring and opened for the seeds they contain.

"By the time the business of gathering the pine cones is over for the season, the nuts and acorns are beginning to ripen, and there are fall apples to be picked and stored in the hollow trees, for the red squirrel is firm in exacting the tithe of the farmers and looks after the collecting of it himself. In the matter of corn, however, he prefers to wait until the farmer has gathered it into his bin, when the squirrel can generally get it without much loss of time."

Genus Tamias Illiger.

Tamias Illiger, Prodromus Syst. Mam. et avium, p. 83, 1811.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{1-1}{1-1}$; M, $\frac{3-3}{3-3} = 20$.

Generic characters.—Size small for a squirrel; tail slender and not very bushy; back striped with five lines of blackish and two of whitish on a ground color of brown; but four cheek teeth on

each side of the upper jaw; cheeks with pouches that open between the teeth and lips.

The six or seven forms belonging to this genus are all geographical races of a single species limited to North America east of the Rocky Mountains. These animals are commonly known as ground squirrels, but that name is also applied to a number of related genera, differing chiefly in number of teeth. The name chipmunk is generally restricted to the squirrels of this genus and is, therefore, the more desirable name to adopt.

TAMIAS STRIATUS (Linnaeus).

CHIPMUNK; GROUND SQUIRREL.

Sciurus striatus Linn., Syst. Nat., ed. 10, Vol. 1, p. 64, 1758.

Tamias striatus Baird, 11th Rep. Smiths. Inst., p. 55, 1857.

Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, pp. 129.

Sciurus striatus lysteri McAtee, Proc. Biol. Soc. Wash., Vol. 20, p. 3, 1907.

Diagnostic characters.—Easily distinguished by its general brown color with five stripes of black and two of light color on the back.

Description.—The chipmunk is too well known to require an elaborate description. The head is brown with a blackish stripe running from the side of the nose through the eye and back to the ear. This is bordered above by a white stripe and that is followed by another narrow, indistinct stripe of blackish. Under the eye there is also a white stripe running from the base of the ear to the cheek. There is another dark but indistinct stripe below this.

The back has a median blackish stripe running from the occiput to the rump. On each side of this are two pairs of alternating pale and dark stripes, the lower light stripe being nearly white, while the median pair are grizzled brown. The rump is bright rufous chestnut and the side and shoulder grizzled yellowish brown with some black tipped hairs; tail grizzled black and gray above and chestnut below.

Measurements.—Specimens from northern Indiana measure 239 mm. 9 9/16 in.) in total length; tail, 95 mm. (3 12/16 in.); hind foot, 30 mm. (1 3/16 in.).

Skull and teeth.—The skull (fig. 5) is slender and tapers gradually from the zygomatic arches to the tip of the nasals, the outlines being much less square than in *Sciurus hudsonicus*, which has a skull of about the same length but broader. The upper cheek teeth are but four in number.

Range.—Chipmunks are found throughout North America east of the Rocky Mountains, except in the boreal regions. The typical *striatus* occupies most of the eastern United States except in New England, northern New York and Michigan and in the mountains. To the north a subspecies, *lysteri,* is found. McAtee* has listed the Indiana form as *lysteri,* but in this he erred, as this northern subspecies has a much paler color, a larger average size and larger hind foot than the specimens from this State.

The chipmunk is found all over Indiana where there are moderately open woods or dry pastures, overgrown with bushes or filled with stumps and rocks.

Habits.—Everyone who has lived in the country, in the southern third of the State at least, is familiar with some of the habits of

a b

FIG. 5.—Skull of *Tamias striatus*: a, lateral view; b, dorsal view. After Baird.

these little animals. There they may be seen, ever watchful and alert, about almost any heap of stones, logs, or the old-fashioned rail fences that have not yet disappeared. If they are approached too closely they dart away for a short distance, taking care not to expose themselves in the open and probably uttering a shrill protest as they go. If pursued they are apt to dart into some burrow or other hiding place at a point where there seems the least probability of escape.

If a burrow is not within reach they can run up a tree without difficulty, but their claws are not as sharp as those of a tree squirrel and they can be easily shaken down.

Their nest is nearly always placed underground, and generally, but not always, the entrance is concealed under a stone, stump or the base of a hollow tree. There is usually very little dirt about the entrance of their burrows, and it is supposed that they carry

* Mam. Monroe Co., Proc. Biol. Soc. Wash., Vol. 20, p. 5.

it away in their cheek pouches, though I know of no one who has ever seen them at it.

For a rodent, the chipmunk has a remarkable vocal ability. His name chipmunk or chipping-squirrel was given to him because of the chipping song he sings as he sits in the bright autumn sunshine. I have heard this chipping at intervals of two or three seconds for fifteen or twenty minutes, with scarcely a note missed. What its purpose may be, I cannot conceive.

A second noise is the rapid chatter he makes in defiance as he dashes away from danger along a fence or wall. But the most startling sound that I have ever known to proceed from any rodent's throat, is the shrill whistle of this little animal. Its exact nature is indescribable, but it resembles the whistle of a bird more than any mammal note that I know of. I have been fooled by it myself, and I once knew two very good ornithologists to search all over a hillside for some unknown bird, only to discover that the call that had lured them was not that of some feathered creature, but the ventriloquistic whistle of one of these little squirrels.

The food of the chipmunks is quite varied. In the oak woods they store up quantities of acorns in the autumn, and these form the staple article of food for several months. All kinds of nuts are eaten when they can be secured, and one of the favorite dwelling places of the animals is in an old pasture where clumps of hazel bushes are interspersed with stone piles or stumps. In the spring they sometimes do considerable damage by digging up sprouting corn from the furrows. In the autumn some corn is taken from the shocks. They also levy tribute on the wheatfields, separating the chaff from the grains and filling their cheek pouches with the latter to be carried to the den and stored for time of need. I have taken 145 grains of wheat from the pouches of an animal killed beside a shock of wheat. Many kinds of wild seeds and fruits are no doubt eaten. In a swampy district in Maryland, I found them storing up seeds of the sweet gum, which is there abundant. One that I caught had nearly 40 of these seeds in his pouches.

The capacity of the cheek pouches is surprisingly large. They open between the lips and the molars and extend along the cheeks and neck beneath the outer skin. They are simply folds of skin that have grown back from the lining of the lips and are not furred inside. They can be stretched to hold a considerable quantity of grain or seeds, as in the two instances mentioned above.

As a rule, the chipmunk does not eat much food at the place where he finds it growing, for he knows his enemies are legion, and

therefore gathers it hastily and carries it to his burrow and stores it there to be eaten at leisure. A quantity is stored up for winter use, for these animals, unlike the woodchuck, do not sleep soundly all through the cold season. They can still be seen scampering about during the warm days in early December, and I have little doubt that they come out sometimes during the warm days of midwinter, although I have never seen them during the last half of December, nor in January and February.

I am not able to say just how they spend the winter months. It is pretty generally believed that they awaken now and then and eat some of the food they have stored up.

Certainly they have need of awakening sometimes, for the sites of their winter homes are not always well chosen. In the autumn of 1906 I noticed that one of these animals was making its home under the roots of a small black gum tree standing on the edge of a sinkhole. It was frequently seen carrying acorns into this den during the late autumn and undoubtedly selected the place for its winter sleep. In January a heavy rain flooded the sinkhole and the water stood above the level of the chipmunk's hole for several weeks. I did not see the animal either then or afterwards, and never learned whether it escaped or was drowned during its winter sleep.

This species, like many others with similar habits, has undoubtedly thrived as the land has been cleared and tilled by man. Although sometimes found in the woods, it is not fond of the dense forests and was not abundant when white men first came to the State. With their coming many of its chief enemies disappeared or were reduced in numbers.

It is most abundant at the present time in the fields that are partially overgrown with bushes and covered with stones. However, it is not averse to living in close proximity to man, and I have known a chipmunk to make its home under the front veranda of a house occupied by a quiet couple who did not molest their little neighbor. At Indiana University a colony has lived for years in the foundation of Owen Hall, all unconscious that some of their pickled or skinned relatives were within, and that animals by the hundreds were being dissected in the zoological laboratories just over their heads.

Economic status.—In some instances chipmunks do much damage by digging up the sprouting corn from the rows. In such cases the squirrels should be poisoned, trapped or shot. A better way is to keep the fields free from heaps of stone, brush or rubbish of any

kind. The animals have also been known to rob the nests of birds. On the whole, however, they do little damage, as most of their food consists of wild seeds and fruits. They are fond of the seeds of the giant ragweed or horseweed, and doubtless do some good by destroying weed seeds. They also eat some insects, though not enough to be of much use in that way.

Genus CITELLUS Oken.

Citellus Oken., Lehrbuch der Zoologie, Vol. II, p. 842, 1816. Allen, Bull. Amer. Mus. Nat. Hist., Vol. 16, p. 375, 1902.

Spermophilus Cuvier, Dents des mammiferes, p. 160, 1825. Baird, Mam. N. Amer., p. 304.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{2-2}{1-1}$; M, $\frac{3-3}{3-3} = 22$.

Generic characters.—Size about that of the chipmunks (*Tamias*) but form generally more slender; tail often scantily haired, slender and rounded; cheek pouches present as in *Tamias;* ears usually short and round; color of the different species various, but never with dark and pale stripes alternating on a chestnut-colored back as in the preceding genus; upper jaw with five cheek teeth on each side.

The genus *Citellus* (usually called *Spermophilus*) as formerly understood contained a great number of species and had a range including most of the north temperate zone. Recently this genus has been divided into several genera, but there is lack of agreement as to what species should be included in each. As now understood, the genus still includes a number of species in America, Asia and Europe.

Two species only are found east of the Mississippi River, and one of these does not extend farther east than north-central Indiana, while the other is found as far east as Ohio. They may be distinguished as follows:

Whitish stripes and rows of dots on the back, in a ground color of brown; length not over 12 inches. *tridecemlineatus.*

Back without any stripes; length about 15 inches. *franklinii*

CITELLUS TRIDECEMLINEATUS (Mitchill).

STRIPED SPERMOPHILE; THIRTEEN-LINED GROUND SQUIRREL.
Also known as the Striped Gopher.

Sciurus tridecemlineatus Mitchill, Medical Repository, New Ser., Vol. VI, p. 248, 1821.

Spermophilus tridecemlineatus Audubon and Bachman, Quad. N. Am., Vol. I, p. 294, 1849. Evermann and Butler, Proc. Ind.

Acad. Sci. for 1893, p. 128. Stone and Cram, Amer. Animals, p. 161, 1903.

Citellus [*tridecemlineatus*] Allen, Bull. Amer. Mus. Nat. Hist., Vol. XVI, p. 375, 1902.

Diagnostic characters.—Back striped with six lines of buffy white and seven wider stripes of brown; stripes on the lower part of the sides not all very distinct, however.

Description.—The ground color of the back is a light chocolate brown when viewed at a little distance, the hairs being banded with chestnut and black. A rather faint row of light spots runs from the back of the head to the base of the tail, through the middle of a brown stripe. On each side of this, the pale stripes alternate with the brown, the latter being all marked with a row of pale dots excepting the outer one, which is usually indistinct and without the row of pale spots. The solid stripes are of nearly uniform width, the light ones being about two millimeters wide and the brown ones six millimeters. On the back of the neck the light spots become joined in a solid stripe. The pale spots vary in distinctness and size. Between them there is often an indistinct spot that is darker than the rest of the brown.

The forehead is tinged with yellowish brown. The lips are pale buff. The ears, lower cheeks, throat, belly and feet vary from pale buff to light yellowish brown. The tail above is chestnut in the middle, this being bordered with a black line which is followed by an outer fringe of buff. Below, the middle is lighter and the black line is indistinct.

The fore feet have very long, comparatively straight claws. The external ear is a mere rim, two or three mm. in height. There are large cheek pouches opening between the teeth and the lips.

Measurements.—Average of three individuals from Porter County: Total length, 275 mm. (11 in.); tail, 101 mm. (4 in.); hind foot, 34 mm (3/8 in.).

Skull and teeth.—The skull resembles that of the chipmunk in form and size. The braincase is usually a little broader in the present species and the skull more convex above. The spermophiles all have five cheek teeth, however, instead of four as in the chipmunks. In the chipmunks the incisors are usually yellow or brown, while in the present species they are white.

Range.—This little ground squirrel has a range extending from Saskatchewan to Oklahoma and from the western border of the plains to northwestern Ohio. In Indiana it is found only in the prairie portion, not extending much south or east of the Wabash

River. It has, however, been recorded from Butler County, Ohio, about 30 miles north of Cincinnati.

Evermann and Butler give the following records: Terre Haute, Lafayette, and Benton, White, Carroll, Newton and Lagrange counties. In addition I can record the species from Fowler, Oxford, Mountayr, Lake County (Ball), Hebron, South Bend, Wolcottville, Lacrosse, Hudson and Winona Lake.

Habits.—This species belongs to a large group of the squirrel family known as the spermophiles, and often incorrectly called gophers. They are typical inhabitants of the great plains and mountains of western America, but only two species are found east of the Mississippi. In many ways they are intermediate between the prairie dogs and woodchucks on the one hand and the chipmunks and tree squirrels on the other. They always make their homes underground and seldom climb trees.

Railway embankments are favorite dwelling places of these animals, at least in northern Indiana, where much of the land is swampy. There is little doubt that they have extended their range, locally, by following railways through swampy districts that are not suited for their habitation and thence spreading out into the drier areas.

Their habits seem to differ greatly in different localities. At Mountayr, in Newton County, I found them living in the pastures and along the fences. The holes leading to their nests were less than two inches in diameter and there was not a particle of loose earth about them. I was at a loss to know what had made the holes until I trapped a spermophile at one of them. The farmer on whose land I caught a number had never seen them, and did not know that such animals were in the neighborhood nor did I ever see them alive in this locality.

Near South Bend, Wolcottville and other places, I have known them to dig holes considerably larger at the mouth and leave the dirt where they threw it out after the manner of woodchucks. In some localities they do not appear to be as shy and may often be seen sitting up on their haunches on the lookout for danger.

Economic status.—In some places where the striped spermophile is abundant it becomes a serious pest. In this State it has never done a great deal of harm to crops. At Mountayr I found them living in a field of ripened oats, but the owner did not think the damage done by the animals was appreciable. Other farmers have told me that they do little harm. One spermophile was examined whose cheek pouches were filled with seeds of the Canada thistle

which he was thus helping to destroy. They also eat some insects, especially crickets and grasshoppers.

However, experience in some of the other States has shown that it is not desirable to allow them to become too numerous. Where they injure crops at all they should be destroyed. They are really taken in "out o' sight" rat traps baited with dry oatmeal or a grain of corn. They can often be drowned out by pouring a bucket or two of water into their holes.

CITELLUS FRANKLINII (Sabine).

THE FRANKLIN SPERMOPHILE; GRAY GROUND SQUIRREL; PRAIRIE SQUIRREL.

Also called Gray Gopher.

Arctomys franklinii Sabine, Trans. Linn. Soc., Vol. 13, p. 587, 1822.

Spermophilus franklinii Baird, Mam. N. Amer., p. 314. Miller and Rehn, Proc. Bost. Soc. Nat. Hist., Vol. 30, p. 49. Evermann and Butler, Proc. Ind. Acad. Nat. Sci. for 1893, p. 129. Stone and Cram, Amer. Animals, p. 162.

Citellus [*franklinii*] Allen, Bull. Amer. Mus. Nat. Hist., Vol. 16, p. 375, 1902.

Diagnostic characters.—Color, dull grayish brown; size somewhat larger than the striped spermophile.

Description.—This spermophile is nearly equal to the gray squirrel in size, but the tail is shorter and not so bushy. The color is brownish gray above, with small, indistinct spots of lighter gray and blackish. The neck and head are hoary and the throat whitish; rest of under parts somewhat tinged with buffy; tail gray; ears small but somewhat larger than those of the striped spermophile.

Measurements.—An adult female from Mountayr, Newton County, measured 375 mm. (15 in.) in total length; tail, 120 mm. (4 4/5 in.); hind foot, 49 mm. (2 in.).

Skull and teeth.—As compared with *C. tridecemlineatus,* the skull (fig. 6) is heavier, flatter on top and more angular. Like that species it has five cheek teeth.

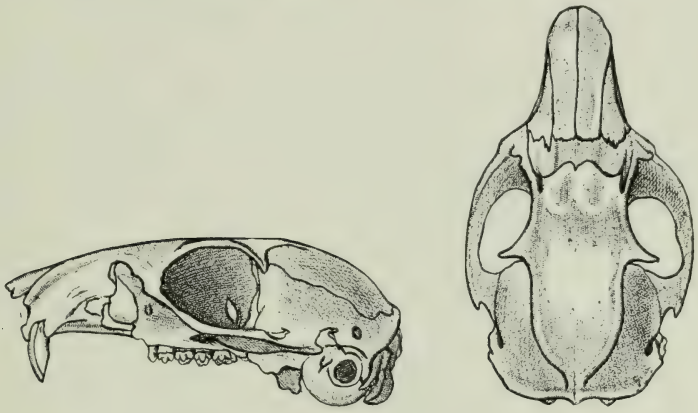
Range.—From Indiana to Kansas and north to Saskatchewan. In Indiana it probably does not occur in more than five or six counties. The only records I have are Remington and Monticello, given by Messrs. Evermann and Butler, and Mountayr and Hebron.

Habits.—At Mountayr I found this species living about a stone pile in a field of oats, and they also had holes, similar to woodchuck holes, but smaller, about a rod from the stone-pile. In

this neighborhood the species was known as the gray squirrel. I was unable to learn of more than the one colony anywhere near.

The animals were not afraid of traps and three were caught in a single trap, without bait, in two days. They were all females, and one taken August 18 appeared to be nursing. The cheek pouches of one contained several crickets and one of the others had been garnering oats. The farmer on whose land they were taken did not think that they had injured his crops appreciably.

Mr. W. S. Blatchley reports digging one of these spermophiles out of a mound near Boone Grove, Porter County, on October 6. At that time it had already begun to hibernate.



a b

FIG. 6.—Skull of *Citellus franklinii*: a, lateral view; b, dorsal view. After Baird.

Economic status.—The Franklin spermophile is not sufficiently numerous in this State to be of much economic importance. In some of the States farther west it sometimes does considerable damage to grain. It eats some insects, but is not beneficial to any marked degree. There is no reason why its flesh should not make good food, though I cannot vouch for its flavor.

Genus MARMOTA Zimmermann.

Marmota Zimmermann, Specimen zoologicae geographicae, p. 509, 1777. Allen, Bull. Am. Mus. Nat. Hist., Vol. 16, p. 17, 1902.

Arctomys Schreber, Saugethiere, Vol. 4, pls. 207-211, 1780.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{2-2}{1-1}$; M, $\frac{3-3}{3-3} = 22$.

Generic characters.—Form heavy and thickset; tail short; ears small; color grizzled brownish or grayish with no distinct stripes;

skull broad, depressed and strong, with straight post-orbital processes; first premolar nearly as large as the second.

The range of this genus includes most of the north temperate zone. The species are not numerous, however, and only one is found in the eastern United States.

MARMOTA MONAX (Linnaeus).

WOODCHUCK; GROUND HOG.

Mus monax Linnaeus, Syst. Nat., ed. 10, p. 60, 1758.

Arctomys monax Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 128, 1894.

Marmotta monax Allen, Bull. Amer. Mus. Nat. Hist., Vol. 16, p. 17, 1902.

Diagnostic characters.—The woodchuck cannot be confused with any other Indiana mammal. Its grizzled, yellowish gray color, heavy body, broad, blunt head and short tail readily distinguish it from all the mammals of the region.

Description.—The predominating color of the head is dark brown, this color being grizzled with paler tipped hairs. The edges of the ears and some spots about the eyes are also paler; a whitish line borders the mouth. The hairs of the back and sides are ringed with silvery gray, blackish and reddish brown. Belly generally rather light reddish brown, often somewhat grizzled. The hairs of the belly are usually scanty so that the skin is visible. The feet are black or dark brown. Tail short and rather scantily haired, the hairs usually having less of the silvery gray band of color and hence the tail is darker than the back. There is a great variation in color, some animals being nearly black and others much more red or gray. I have also heard of albinos, but have never seen any.

Measurements.—The size varies greatly. Woodchucks usually appear very much smaller in the spring than in late summer, when they are fat and strong. An adult female from the Kankakee Valley, the largest specimen of which I have any measurements, though probably not the maximum size of the species, had a total length of 615 mm. (24½ in.); tail, 145 mm. (5 13/16 in.); hind foot, 93 mm. (3 12/16 in.).

Skull and teeth.—The skull (figs. 3 and 7) is characterized by its very broad flat top, or dorsal, surface and angular outlines. The incisors are long and broad; the lower jaws are very imperfectly fused together and readily come apart in the cleaned skull. Not infrequently in the living animal they become slightly dislocated, the upper incisors do not meet the lower ones exactly and both con-

tinue to grow indefinitely, sometimes penetrating the flesh and even the bones of the skull. The molar teeth have prominent, W-shaped crowns which do not wear smooth, even in old age.

Range.—The woodchuck's habitat extends from New England and North Dakota to Georgia and Louisiana. Other species are found to the north and west. In Indiana it is found in every county.

Habits.—The woodchuck, or ground hog, as he is more often called in southern Indiana, is noted for his long winter's sleep. Retiring to his burrow when the first hard frosts come, he shuts

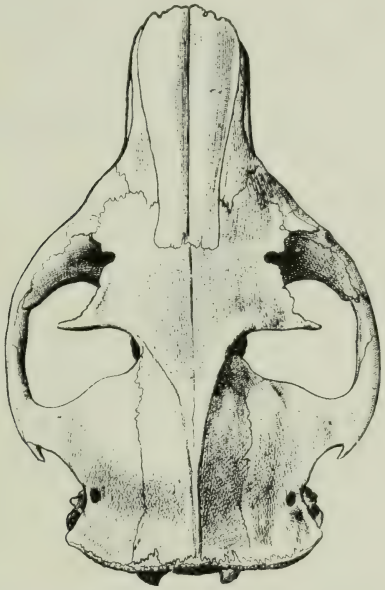


FIG. 7.—Skull of *Marmota monax*. After Baird.

himself off from the world with a goodly pile of earth and sleeps in blissful ignorance of winter and its cold. The popular idea that he comes out on a certain day is nothing more than a superstition, just as it is a superstition that leads people to believe that the coming of spring can be forecasted by the cloudiness of the sky on the second of February.

If the winter nap of our sleepy friend does not have a regularity that would seem to make an alarm clock a necessary part of the equipment of his burrow, its length can nevertheless be foretold with some degree of accuracy. In southern Indiana the animals usually retire about the middle of October. I have seen them on

the 14th of that month after the severe early frost of 1906; but I have never seen them as late as November, although it is possible that a few may venture out in the sunshine of that month. I do not know that they ever appear as early as February 2, which is popularly styled "ground-hog day." Before the end of February, however, they usually begin to clean out and enlarge their burrows or dig new ones.

After they once venture out, snow and cold do not drive them back to winter quarters, and their tracks may often be seen in the deep snow that sometimes falls in March. At such times they subsist largely on tender twigs and young trees. This food could be obtained by them throughout the winter, as well as by the rabbits, who find it ample for their winter diet. The hibernation of the woodchuck, then, can not be looked upon as an adaptation necessary for the animal's existence. It is rather a physiological peculiarity which may possess advantages, but which does not have selective value.

Even during the summer the greater part of the time is spent in sleep. Except during the breeding season these animals are usually active only for brief periods two or three times a day. The rest of their existence is spent within their burrow, presumably in sleep. It is easy to see how a creature with such a vegetative existence could acquire the habit of prolonged sleep after it has stored up a large quantity of fat, though it is not so easy to see why some of the leaner animals do not waken in December or January, and I have never known such a thing to occur.

It is said that a hibernating woodchuck cannot be dug out unless by accident or by excavating a large area about his den, because he plugs the passage into which he crawls with dirt so tightly that it cannot be found. When pursued into his den during the season of activity, he also fills the passages so that he cannot be readily found, and at such times he can also extend his burrow very rapidly.

The food of the woodchuck is quite varied. Tender clover and ripe apples are favorite articles of diet. But many kinds of grasses twigs, leaves, stems and vegetables are eaten at times. I once captured one of these animals in a sassafras tree and, on examination, found its stomach gorged with sassafras leaves.

The animals that live in the fields seldom forage far from home. The den is located in a place convenient to feeding grounds. The owner comes out early in the morning, stopping near the door of his home to rise up on his haunches and survey the horizon for pos-

sible danger. If the coast is clear he wanders off, usually following a path of his own making and nibbling clover or grass on the way. He does not forget to rise up on his haunches and look for danger, even while feeding. In the spring, while lean and hungry, he may stay out for an indefinite length of time. Later in the summer he usually returns in an hour or two, and perhaps does not come out again till late afternoon. At this time he sometimes goes for a visit to his neighbor across the field, but most often he stays near home, although he may prolong his supper till after nightfall. Sometimes he comes out for a midday lunch also.

If discovered away from his burrow he knows but one thing to do—get back to safety at once. Under such circumstances he does not hesitate to run directly toward a person and his rush is so impetuous that one is apt to be knocked down if he remains in the animal's path. If cornered the woodchuck at once shows fight, and his long, powerful incisors make him a formidable antagonist for any inexperienced dog.

At the present time men, dogs, and possibly foxes, are the only enemies the adult woodchuck has to fear. For this reason the species has increased in abundance in recent years, where formerly their numbers were held in check by such carnivorous animals as wolves, coyotes, bears, panthers and lynxes. The writer can remember when, somewhat more than twenty years ago, an older brother killed a woodchuck and all the boys and some of the men in the neighborhood were ignorant as to the identity of the animal. At the present time the same farm in southeastern Indiana harbors from 25 to 50 "ground pigs," as they are popularly called, and their appearance is doubtless familiar to every country boy in the State.

Economic status.—The woodchuck has no good qualities and many evil ones. The animal is a voracious eater during the seasons that crops are growing. Besides eating a great quantity of clover, grass, some grain, a little fruit, and occasionally garden vegetables, they make paths through the meadows and grain fields, and tread down more than they eat. Where there are few on a farm, the loss is not very noticeable, but where they become abundant they do much damage. In some localities they have become such pests that bounties are offered by the county. Porter County paid out $700 in such bounties during the five years ending with 1905. At ten cents apiece, this means an average destruction of 1,400 woodchucks per year. The numbers were not appreciably diminished, however, and the money might have been expended with

much better results. An ounce of bisulphide of carbon soaked into cotton or an old rag and thrown as far as possible down the hole of a woodchuck will usually asphyxiate the inhabitants. The fumes of this chemical are heavy and go downward, so that it is not necessary to cover the hole if care is taken to throw the substance as far down as possible.

Poison can sometimes be put in a ripe apple, which should then be left along the paths used by the animal at a little distance from the den. This, of course, can only be done where there is no danger of man or domestic animals eating the poisoned fruit.

In the early spring when the animals are still weak from the winter's fasting they can often be caught by setting a steel trap well down inside the hole and partially covering it with dirt. There is a chance, however, that the animal will bite off the foot just below the jaws of the trap and thus free itself. In late summer it requires a very strong trap to hold a full grown woodchuck, as they are then very strong and their first effort, when entrapped, is to pull free, and in this attempt they are often successful.

The flesh of these animals is said to be tender and well flavored. The woodchuck is a dainty feeder, usually eating nothing but juicy fruits and tender grass and clover, and there is no well-founded reason for thinking him unclean. There is, however, a strong antipathy among many people to eating most kinds of animals with whose flesh they are unfamiliar. If a taste for the meat of these animals could be cultivated, it would help to solve the problem of getting rid of a serious pest.

Genus Sciuropterus Cuvier.

Sciuropterus Cuvier, Dents du mamiferes, p. 255, 1825.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{2-2}{1-1}$; M, $\frac{3-3}{3-3} = 22$.

Generic characters.—A membrane extends along the sides of the body from wrist of fore-limb to ankle of hind leg. The body is covered with very dense, long, soft fur, pure white underneath, varying from gray to brown on the back and without distinct spots or markings of any kind. Tail very broad and flat. Skull much depressed posteriorly. Fore-limb with a supplementary bone articulating with the outer side of the wrist and helping to expand the membrane.

The genus is represented by several species in North America as well as Europe and Asia. Only one species is found in Indiana

SCIUROPTERUS VOLANS (Linnaeus).

FLYING SQUIRREL.

[*Mus*] *volans* Linn., Syst. Nat., ed. 10, Vol. I, p. 63, 1758.

Sciuropterus volans Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 131, 1894.

Diagnostic characters.—Distinguished by the membrane which extends from the fore leg along the side to the hind leg.

Description.—Fur very dense and soft. Color, brownish drab above, with the under parts pure creamy white from chin to tail, the hairs being white at the base as well as the tip, a somewhat unusual condition among mammals. The cheeks are whitish and there is an indistinct dark ring around the eye. The fore feet are white; hind feet brown above, excepting the toes.

The ears are small and rounded. The fur of the tail is dense and long, standing out at the sides, thus making the tail very broad and flat. The membrane which extends along the flanks is merely a double fold of skin produced from the sides and belly. In skinning the animal it is apt to split open from the inside.

Measurements.—An adult male from Mitchell measured 230 mm. (9¾ in.) in total length; tail, 97 mm. (4 in.); hind food, 28 mm. (1⅛ in.).

Skull and teeth.—The skull is distinguished from that of other squirrels found in Indiana by its small size and rounded form. The braincase is depressed at the back; postorbital processes very short. Rostrum short and sharply marked off from the broad interorbital region. Cheek teeth five in number, the first one small and so closely applied to the second as to be easily mistaken for a part of it.

Range.—This species of flying squirrel has a range from New England to Georgia and west to the plains. Other species are found in the west, south and north. In Indiana it doubtless occurs in every county.

Habits.—Flying squirrels are almost as numerous in some localities as gray squirrels, but they are seldom seen because of their nocturnal habits. During the warm nights that come in late February, March and April their shrill, bird-like calls may be heard in almost any woodland by him who knows how to listen.

During the late summer they may sometimes be seen in the evening twilight, sailing from some lofty point to the base of a tree not far away. They cannot be truly said to fly, for they do not propel themselves while in air, but gather impetus in leaping

from a solid body. The membranes along the flank act as a parachute to bear them up, and the broad tail also aids in supporting them in air and doubtless serves as a rudder, enabling them to alight with more certainty. It is worthy of note that some Asiatic flying squirrels that have slender, round tails have the membrane extended back of the hind limb and joined to the base of the tail.

The young are born about the first of April. They are usually from two to four in number and are brought forth in a deserted woodpecker's hole or knot hole in a tree. If taken while young they become very tame and make pretty and interesting pets. Prof. F. H. King* writes of some that he had: "I have never known wild animals that became so perfectly familiar and confiding as these young squirrels did; and they seemed to get far more enjoyment from playing upon my person than in any other place, running in and out of my pockets and between my coat and vest. After the frolic was over they always esteemed it a great favor if I would allow them to crawl into my vest in front and go to sleep there where they felt the warmth of my body. When forced to go to sleep by themselves, the attitude taken was amusing. The nose was placed upon the table or other object it happened to be upon, and then it would walk forward over it, rolling itself up until the nose almost protruded between the hind legs; the tail was then wrapped in a horizontal coil about the feet, and the result was an exquisite little ball of life in soft fur which it seemed almost sacrilegious to touch."

Even the adult animals reared in the wild state are fond of living near human habitations. Mr. E. J. Chansler writes me: "Some twenty years ago we lived in a little cabin by a creek. While eating supper about dusk, we would hear a racket in the board loft, and presently the flying squirrels would sail down and light on the table and eat with us. They kept this up for quite a while." A colony has lived for a long time on the campus of Indiana University, apparently as oblivious of the people about them as most of the students are of the presence of the squirrels. They also live near the cabin on the University's property at Mitchell.

During the winter season they are quite gregarious and numbers may often be found together. Prof. U. O. Cox reports finding fifteen in a hollow snag in Randolph County on a Thanksgiving day. (Evermann and Butler.) When asleep in a hollow tree they usually come out if the tree trunk is rapped sharply. Sometimes the entrance to their home is at the ground and I have caught them

* Quoted in American Animals.

in a trap placed on the ground beside a hole in the base of a hollow tree.

Economic status.—The food of the flying squirrels consists chiefly of acorns and nuts. I doubt that they ever injure standing grain or crops of any kind, although they may sometimes steal from granaries and corn cribs. They are said to eat some fruit, a few insects, and, occasionally, carrion.

Family CASTORIDAE.

BEAVERS.

Size large for a rodent; habits aquatic; tail broad, flat, and almost devoid of hair.

Genus Castor Linnaeus.

Castor Linnaeus, Syst. Nat., ed. 10, Vol. I, p. 58, 1758.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{1-1}{1-1}$; M, $\frac{3-3}{3-3} = 20$.

Generic characters.—Size the largest of any North American rodent; tail broad and horizontally flattened; skull very strong and without postorbital processes.

The genus formerly had a range extending from Mexico to the Arctic zone and throughout Europe and more or less of Asia. There were but few species, however, and these are now very generally exterminated except in the thinly settled regions. A single species with several geographic races is found in eastern North America.

CASTOR CANADENSIS CAROLINENSIS Rhoads.

CAROLINA BEAVER.

Castor canadensis carolinensis Rhoads, Trans. Amer. Philos. Soc., Vol. 19, p. 420, 1898.

Castor fiber Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 128.

Diagnostic characters.—Those of the genus. The southern form, *carolinensis* is said to be distinguished from the northern beaver by its lighter color, larger size and much broader tail. No specimens from Indiana are to be had, but it is assumed for geographic reasons that the southern form is the one that formerly occurred in this State.

Description.—Rhoads says of the color of the two races: "The upper winter fur of *canadensis* is blackish brown, the hairs tipped with chestnut, rump and thighs dark chestnut. In *carolinensis* the

upper colors are hazel brown and the rump and thighs bright cinnamon rufous, the under parts broccoli brown, making it a much duller and paler colored animal than the Canadian beaver."

The general appearance of beavers is well known. The form is short and thick-set, the hind feet webbed and with but four toes, the second toe having two claws. The tail is broad and flat, devoid of hair but covered with scales.

Skull and teeth.—The skull is extremely large and strong, with large flat molar teeth and strong processes for the attachment of the muscles used in mastication.

Range.—The Carolina beaver formerly ranged throughout the eastern United States, except New England, the Allegheny Mountains and possibly the Canadian border, in which places the Canadian beaver replaced it.

In Indiana it was once found throughout the State, but disappeared almost as soon as the bison and elk. The Prince of Wied states that it was exterminated at New Harmony previous to 1832, and Dr. Plummer wrote in 1844 that beaver dams were still to be seen about Richmond, but he knew of no one who had ever seen beavers there. However, Mr. E. J. Chansler tells me that a beaver was taken near Vincennes in 1840 by Mr. F. Dubois. Evermann and Butler say that a beaver was taken near New Harmony "not many years ago" (1888). They also say that a beaver was seen in the Wabash River near Lafayette in 1889. I place little credence in these last two records, for the consensus of opinion is that the species was exterminated all over the State not later than 1840.

Habits.—Most natural histories contain good accounts of the habits of beavers, and this account will, therefore, be less extensive than these interesting animals might otherwise deserve. Macfarlane states that in the Northwest territories of Canada the beavers mate in January or February and from four to eight young are born three months later, the usual number of young for a mature female being four, five or six. They are small and quite naked and helpless at first, but grow rapidly and in a few weeks begin to eat succulent plants. The females do not breed until about three years old. The males fight desperately for mates during the breeding season, but apparently remain faithful to the mates they choose and assist in rearing the young.

These animals have instincts specialized to a high degree and are commonly supposed to be very intelligent, although it has not been shown that their intelligence extends very far in the way of

ability to meet new situations. They dam streams in order to form ponds of suitable depth, and in these ponds they construct houses of sticks and mud. The sticks are obtained by cutting down trees near the water and are sometimes six inches or more in diameter. They are cut with the teeth and it has often been asserted that the lowest and deepest cut is on the side toward the water, so that the tree will fall in the direction that will save work in carrying it. This point is disputed, however, and it is probable that if the trees fall toward the water it is because they lean that way and not because the beavers exercise extraordinary wisdom in cutting them.

The food of beavers is bark which they obtain by cutting trees and which they store up for the winter. They also eat tender aquatic plants. In storing sticks of wood for winter food they do appear to show considerable intelligence, for it is said that they usually place their supply so that it will not be carried away by a flood. The dam and the banks of the pond are also carefully guarded and strengthened to prevent breaking in time of high water.

The cause of the early extermination of this species is to be found, in part, in the extraordinary persecution to which they are subjected. The coat of the beaver has always been one of the most valuable of furs, and Macfarlane states that the Hudson's Bay Company exported an average of more than 118,000 beaver skins from Canada each year from 1853 to 1877, while as late as 1903 they sold over 49,000 skins. In addition to the fur, beavers yield a product called castoreum, which is used in perfumery and other drugs. It is secreted by glands associated with the reproductive organs.

The habits of the animals in associating together in colonies, the presence of which are indicated by dams and ponds, has also aided in the extermination of the species by making it easier for trappers to locate the animals. Compared with the muskrat and many other rodents, the rate of reproduction is slow, since the animals do not breed until three years old.

Where they are protected they soon increase, however, and according to Mr. Macfarlane the Hudson's Bay Company has done a valuable service in limiting the catch and preventing extermination in the Northwest territories of Canada. It seems altogether possible that the animals might be successfully reared in confinement if given a good range and plenty of cottonwood, birch, ash and other trees suitable for food and for making dams and houses.

Family MURIDAE.

RATS AND MICE.

Size ranging from some of the smallest of mammals to the muskrat, which weighs several pounds. There is a single incisor on each side of the upper and lower jaw; no canines or premolars; molars three on each side of the upper and lower jaws.

The family is of world wide distribution and includes over 100 genera and more species than any other family of mammals. The tropical species, which are very numerous, are still imperfectly known and many new species and genera will yet be found.

The American rats and mice belong to four subfamilies which can generally be very easily distinguished. To the *Murinae* belong the introduced mice and rats which are all well-known household pests. They are characterized principally by the long, scaly, nearly hairless tails, and by having the tubercles or projections on the crowns of the molar teeth of the upper jaw arranged in three rows.

The second group, *Cricetinae*, includes many old world species and all of the white-footed mice, harvest mice, grasshopper mice and others of North America. They have also moderately long tails, slender limbs and bodies and many of them have white bellies, large ears and prominent eyes. The tubercles of the upper molars are arranged in two rows.

The third group, *Microtinae*, includes the meadow mice or voles and the muskrat. With the exception of the muskrat they all have short tails, short legs, small eyes and ears and plump, thick bodies. The crowns of the molars are without projecting tubercles, but are flat and are arranged in a series of loops and triangles which project from the middle line on both the inner and outer side of the teeth.

The fourth group, *Neotominae*, includes the native cave rats and wood rats, of which only two or three species are found east of the Mississippi and none have certainly been recorded from Indiana. They resemble the house rat in external form, but the belly is pure white, the tail is more thickly covered with hair and the teeth bear considerable resemblance to those of the *Microtinae*. They were formerly placed in the subfamily *Cricetinae*, to which they are related, but more recently they have been regarded as forming a separate subfamily.

Genus Mus Linnaeus.

Mus Linnaeus, Syst. Nat., ed. 10, p. 59, 1758.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{0-0}{0-0}$; M, $\frac{3-3}{3-3} = 16$.

Generic characters.—Front teeth without grooves; molar teeth with tubercles of the crowns in three rows (these not evident in the teeth of old animals, where the crowns are worn smooth); tail long, scaly and scantily haired.

Three species are found in this State, all of which have been introduced. The genus has a cosmopolitan distribution and is represented by a very great number of species, chiefly in the tropical regions of the old world.

The Indiana species may be distinguished by the following key:

Size small, under 200 mm. (8 in.). *M. musculus.*
Size large, 300 mm. (12 in.) or more.
Color bluish black; tail as long or longer than the head and body; form slender. *M. rattus.*
Color brownish; tail shorter than head and body; form rather stout. *M. norvegicus.*

MUS MUSCULUS Linnaeus.

HOUSE MOUSE.

Mus musculus Linnaeus, Syst. Nat., ed. 10, p. 62, 1758.

Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 127, 1894.

Diagnostic characters.—Size small (6 to 7 in.); color "mouse gray," often with a tinge of yellow on the belly, but never with bright brown back and white belly; eyes and ears of moderate size; tail scantily haired and scaly; skull small and delicate as compared with the white-footed mouse.

Range.—The house mouse probably came from Asia, but it is now a household pest throughout the civilized world. It reached America with the first colonists, and doubtless has lived in Indiana almost from the time of the first permanent white settlements.

Habits.—Not only are the house mice found in almost every house and barn in the State, but they have also taken up their abode in the fields. When the farmer takes up his shocks of grain or fodder several species of mice are apt to scamper away, and among them some house mice are very often seen. I have also found them living in the open grassy fields in half a dozen counties. They no doubt go back and forth more or less between field and barn and spend their time wherever they can most easily obtain food.

Their depredations in granary and pantry are too well known to require discussion. They can squeeze through a hole surprisingly small and often get into a room that is supposed to be mouse-proof. If nutritious food is not at hand they seem to be able to live for a time on almost any substance that they can swallow. A friend once told me that he had very carefully put away everything that it seemed possible for mice to eat for several weeks in the hope that they would leave his house. In this he was disappointed, and he then began setting traps. Several mice were caught, and on examination it was found that their stomachs were filled with paper. This had apparently been sufficiently nutritious to keep them alive for some time.

No satisfactory means of getting rid of mice has ever been discovered. Like the rain, they come alike to "just and unjust," the rich and the poor. However, it is possible to exclude them from the rooms of a well built house, and good floors, closely fitting doors and screen wire placed over ventilators, hot air shafts or other necessary openings will go farther than anything else to prevent damage by mice and rats.

MUS NORVEGICUS Erxleben.

COMMON OR NORWAY RAT.

Mus norvegicus Erxl., Syst. regni animal, Vol. 1, p. 381, 1777. Miller and Rehn, Proc. Bost. Soc. Nat. Hist, Vol. 30, p. 65.

Mus decumanus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 127.

Diagnostic characters.—Body heavy, covered with coarse, brownish-gray fur. Tail scarcely as long as the head and body together, covered with prominent scales which are interspersed with few hairs. Further description of this animal seems unnecessary.

Range.—Originally coming from Asia, this pest has been carried by man to all parts of the world. It is said to have been introduced into America about 1775. In this state, according to Dr. Haymond, it first reached Brookville in the summer of 1827. Dr. Plummer gives the date of its arrival at Richmond as 1835, and Mr. Chansler states that it reached Vincennes about 1840. In all of these places the black rat, which had preceded it, was driven out in from two to five years.

Habits.—Most people are all too familiar with some of the habits of the brown rat. It lives principally about barns, under houses and about wharfs and sewers. It digs great holes under buildings and cannot easily be captured in such places.

The rate of increase is very rapid. The period of gestation is short, and the female produces from four to twelve young three or four times a year. Females begin to breed when only four or five months old, and the potential number of descendents from a single pair of parents within twelve months may be computed at 700 or more, although the actual number is always much less.

In addition to destroying a large amount of valuable commodities, rats are known to spread disease. It is not improbable that they may sometimes spread tuberculosis, and infection of the bubonic plague has been directly traced to these rodents.

Methods of Destruction.—Rats may sometimes be captured by setting steel traps in their holes or paths and covering them with loose dirt, but the animals often escape by sacrificing a foot. Wire cage traps are sometimes effective and may capture several in a night. They are shrewd animals, however, and those that live to maturity become adepts in avoiding traps. The newer styles, which consist of a wood or metal base, to which is attached a loop of stiff wire driven by a coiled spring, are the most effective. Dry oatmeal, cheese, sausage (especially "wiener wurst") or buttered toast, make excellent baits.

The United States Department of Agriculture has issued a bulletin dealing with methods of destroying rats from which the following facts are taken:

One of the most effective means of destruction is the use of barium carbonate or barytes. This is a mineral poison without taste or smell and, in small quantities, is harmless to larger animals. Its action is slow and the rodents usually leave a building to seek water and their bodies do not, therefore, decay about the premises and produce the offensive odors which make other poisons so objectionable.

It may be made into a dough, using one-fifth barytes and four-fifths cornmeal, or one-eighth barytes and seven-eighths oatmeal; or it may be spread on bread and butter or moistened toast. The poisoned bait should be dropped into the rat runs in small quantities. If it is not at once effective it should be tried again with another bait.

Strychnine and arsenic are also effective poisons, and the dry powder can be put into sausage, cheese or raw meat; or it may be dissolved in boiling water, with sugar added to kill the bitter taste, and the sirup may then be mixed with oatmeal or poured on bread, or wheat or corn can be soaked in it over night. The objection to strychnine is that it is so virulent that rats die on the premises

and their bodies being usually in places where they cannot be easily reached, they decay and produce a very disagreeable odor. Arsenic is not always effective in killing rats. Phosphorus, which is sometimes used, is also ineffective unless made very strong, and it then become dangerous to property because it may ignite and start a fire.

Ferrets and dogs trained to catch rats are often very effective in ridding premises of the pests, but for the person who has no time to train and assist them, they are not usually of great value.

However, the most effective method of dealing with rats is to construct houses, barns and outbuildings so that the rodents can not get into them. The use of concrete for walls and floors, if the walls are put down deeply, will usually keep them out. It is necessary to use a fairly thick layer of concrete and to lay all drains and water pipes in concrete. Ventilators or other openings should be covered with wire netting. The exercise of care in making buildings rat proof at the time of construction will more than repay the additional cost in actual saving of money, to say nothing of the annoyance it obviates.

MUS RATTUS Linnaeus.

BLACK RAT.

Mus rattus Linn., Syst. Nat., ed. 10, p. 61, 1758. Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 127, 1894.

Diagnostic characters.—More slender than the preceding species; tail longer than the head and body together; color bluish black with little or no brown fur.

Range.—This was the common rat of Europe in the early historic times. It was introduced into America at the time of the earliest settlements and thrived for about two centuries, when the larger brown rat appeared and drove it out. This species probably reached Indiana soon after the first permanent settlements were made and it disappeared within a few years after the Norway rat appeared. Mr. Chansler says that it was last seen near Vincennes about 1845. Evermann and Butler say that Dr. Haymond included it in his Franklin County list in 1869, but I understand that he includes it as an exterminated species. Dr. Plummer also says that it disappeared within a few years after the coming of its larger relative.

Recently the species has been found in the State again. An

individual,* now in the State Museum at Indianapolis, was taken at New Albany, December 6, 1904. It doubtless reached this place in a shipment of goods from some southern port.

Habits.—The habits of this species are similar to those of the common rat. That is probably the reason the two species cannot exist together and the larger drives out the smaller. This species is said to be less of a nuisance, however, because it is smaller and less aggressive. The black and white rats, often kept as pets and for psychological and bacteriological experiments, are probably derived from this species.

Genus Peromyscus Gloger.

Peromyscus Gloger, Gemein. Hand und Hilfsbuch d. Naturgeschichte, Vol. I, p. 95, 1842 (*Hesperomys* of Baird. *Calomys* of Evermann and Butler.). Osgood, North American Fauna No. 28, 1909.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{0-0}{0-0}$; M, $\frac{3-3}{3-3} = 16$.

Generic characters.—Size and form similar to the house mouse (*Mus*) from which the genus is distinguished by having two rows of tubercles on the molar teeth instead of three and by the white under parts of the body. No other mice recorded from Indiana are apt to be confused with those of the genus *Peromyscus*, although there are genera in the south and west which resemble it. Of these the little harvest mouse (*Reithrodontomys*) may yet be found in the State. It is distinguished by its small size and grooved upper incisors.

The range of this genus is limited to North America and the extreme northern corner of South America. The species are among the most plastic of any mammals known, varying with every change of climate and physical surroundings. More than 150 species and subspecies are known. Three forms are recorded from Indiana and a fourth may sometime be found in the southern part of the State. They may be distinguished by the following key:

Color of both young and adults, bright golden or fulvous.
nuttalli, appendix.

Color of young, dull bluish gray; of adults, fawn color, grayish or brownish.

* This may possibly be a roof rat, *Mus alexandrinus* Geoffroy, often classed as a variety of the black rat. The specimen is stuffed out of proportion and I have had no chance to examine the skull, but it seems to agree perfectly with the black rat in color. The roof rat is common in parts of the southern states and might easily have been carried up the river on a boat.

Adults fawn color, with a very dark dorsal stripe; tail about two inches; skull small. *bairdi*, p. 502.

Adults in fall and winter, bright rusty brown, with a broad median stripe of blackish. *leucopus*, p. 496.

Adults similar, but with the brown more obscured by dusky tipped hairs and the dorsal stripe less distinct. *noveboracensis*, p. 497.

PEROMYSCUS LEUCOPUS (Rafinesque).

WHITE-FOOTED MOUSE; DEER MOUSE; WOOD MOUSE.

Musculus leucopus Rafinesque, Amer. Month. Mag., Vol. III, p. 446, Oct. 1818.

Hesperomys leucopus Baird, Mam. N. Amer., p. 459, 1857.

Calomys americanus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 127.

Peromyscus leucopus Thomas, Ann. and Mag. Nat. Hist., 6th Series, Vol. 16, p. 192, 1895. Osgood, N. Am. Fauna No. 28, p. 113, 1909.

Diagnostic characters.—Somewhat larger than the house mouse and easily distinguished from it by the white under parts, large ears and great protruding eyes; it is less easily distinguished from the other species of white-footed mice.

Description.—Color dark, the middle of the back being very slightly darker than the sides and face; underparts white with a somewhat slaty basal region on the hairs; tail not very densely haired; ears dusky, with a margin of whitish; hairs of ears short.

Measurements.—Osgood gives the following measurements for a specimen from Hickman, Ky.: Total length, 168 mm. (6¾ in.); tail, 73 mm. (3 in.); hind foot, 19 mm. (¾ in.).

Skull and teeth.—As compared with the house mouse, the skull is much larger. Rostrum long and narrow, with its lateral margins nearly parallel; dorsal profile arched; interorbital region constricted; upper incisors narrow. The molars have the tubercles of the crowns arranged in two rows. In old individuals these are apt to be worn down smooth. The skull is slightly smaller than that of the next subspecies.

Range.—As defined by Osgood the range of typical *leucopus* is from southwestern Indiana to Louisiana and from eastern Virginia to Oklahoma. He does not give any positive records from Indiana, but mentions New Harmony specimens as being "doubtful" in position. His selection of a type locality just within the edge of the range of a form which he re-defines, is unusual, and it remains to be seen whether other mammalogists will accept his conclusions.

Inasmuch as the type locality, whether we accept Hickman, Kentucky, which is designated by this author, or the one that has been currently accepted, the pine barrens of Kentucky, is much nearer our boundaries than that of the subspecies, it seems best to include the species in our list.

Habits.—The habits resemble those of the subspecies following.

PEROMYSCUS LEUCOPUS NOVEBORACENSIS (Fischer).

NORTHERN WHITE-FOOTED MOUSE.

Mus sylvaticus noveboracensis Fisher, Synopsis Mammalium, p. 318, 1829.

Peromyscus leucopus noveboracensis Miller, Proc. Bost. Soc. Nat. Hist., Vol. 28, p. 22, 1897. Osgood, N. Am. Fauna No. 28, p. 117, 1909.

Diagnostic characters.—Similar to *P. leucopus*, but slightly larger, less brown in winter and with the dark dorsal stripe lacking or poorly defined.

Description.—Of about fifty mice of this species now before me, from a number of localities in the State and representing all ages and seasons, the brightest colored individual is one taken at Mitchell on October 21, 1906. The color all over the upper part of this specimen is bright, deep fulvous. On the top of the head, neck and back, there are a number of long, coarse black hairs that overlie the others and give a darker tinge, but there is no distinct stripe. Hairs of throat and lips pure white; those of belly, chest and legs, white at the tips and plumbeous at the base, the dark color showing through somewhat.

All other specimens taken in the winter coat have either a fairly distinct dark band down the middle of the back or a suffusion of blackish all over the back. In March and April most individuals are noticeably darker and the darkening continues until in midsummer the predominating tint is dark bluish gray with a suffusion of brownish on the legs and flanks. At this season the color of the dorsal surface closely resembles that of some house mice. This change of color is due, in part, to the wearing away of the brownish tips of the hairs and perhaps in part to a fading of the color. The under surface also becomes grayer in the worn summer pelage, because of the wearing off of the white tips of the hairs.

The young are at first plumbeous all over excepting the belly, the hairs of which are always tipped with white. The flanks first become covered with brownish hairs and this color spreads to the thighs, shoulders and cheeks. At this stage, which is reached short-

ly before adult size is attained, the animals often have a very sharply defined stripe of plumbeous on the back, bordered on each side by brownish. The bright fulvous color is not usually attained till the approach of winter.

Measurements.—Ten specimens from Mitchell average: Total length, 157.6 mm. (6 5/16 in.); tail, 70.3 mm. (2 12/16 in.); hind foot, 19.1 mm. (11/16 in.). The same measurements for ten specimens from the Kankakee valley are 171.2, 80.3, 20. Average of ten from Knox County, 167, 74, 20; five from Bascom, 159, 75, 19.2.

Skull and teeth.—The skull and teeth are essentially like those of the preceding form.

Range.—The northern white-footed mouse is found from Nova Scotia to Minnesota and south to Virginia and Kentucky. Throughout most of this large area it is the most abundant mammal. In this State it occurs in every county unless specimens from the southern part be considered as belonging to typical *leucopus*.

Habits.—Although the white-footed mouse is one of our most abundant mammals, many people know very little about its habits. One reason is that these mice are nocturnal and do not often show themselves during the day. Often the species is not distinguished from the house mouse in spite of the striking difference in color and proportions.

It also resembles the house mouse in being able to adapt itself to a variety of conditions. The species is equally at home in woods or fields. In the woods the creatures usually make their homes under a decaying log, in a hollow log or in the base of a tree. They also use underground tunnels, and when we see a small, clean-cut hole going down through the moss near the base of a maple or oak, we may feel pretty sure that a white-footed mouse has a home safely hidden among the tangled roots beneath.

In the open fields these mice are not abundant. But they do not at once desert their old habitat when a piece of woodland is cleared. The roots of the stumps are still considered good places in which to make their homes, and if the field becomes overgrown with weeds and bushes, these mice consider it their own especial property and there they thrive and multiply.

The old-fashioned rail fences also make good harboring places for these mice, and rock-piles are regularly tenanted by them. Houses and barns are sometimes entered, especially if situated in the edge of a wood, but this species does not thrive in such close relationship to man as the house mouse does, and has never become a household pest.

Sometimes they enter caves. A colony of these mice has existed in Marengo Cave since its discovery in 1883, but they remain near the entrance, and there is no evidence to show that they have ever become isolated in the cave. Their nocturnal habits would fit them well for taking up a subterranean life, but it is doubtful whether there is ever a food supply in any cave sufficiently constant for the animals to become permanently established.

The adaptability of the white-footed mice is of great advantage to them, and their ability to live in all sorts of places accounts for the fact that they are everywhere one of the most abundant of our small mammals. Under natural conditions their food consists principally of the seeds of various trees, shrubs and other plants. The seeds of the wild plum are almost invariably garnered by them in old pasture fields, and the giant ragweed seeds are also an important item in their diet in such places. In the woods, nuts, acorns and the seeds of the tulip poplar are among the most important articles of food.

Where they come in touch with cultivated crops they are not slow in learning to take a share for themselves. Corn shocks left long in the field, at least if it is near woods or brushy pasture, are sure to be inhabited by some of the mice, and they have a grotesque appearance as they bound away from the uplifted shock with their great eyes protruding, their large ears standing straight, and the tail sticking out stiffly behind.

The white-footed mice make pretty and interesting pets if captured while young. The following observations on the habits of this species, made at Mitchell, are quoted from the author's paper on the vertebrates of the Indiana University Farm. (Proc. U. S. National Museum, Vol. 35, p. 573.)

"A number of white-footed mice were kept in captivity at different times, but they could not be kept together. On one occasion six were caught under corn shocks and were divided equally between two cages. Next morning each cage contained two partially eaten carcasses, while of the survivors in each cage, one died within a few hours and the other a day later.

"A male taken when half grown became so tame that it would eat from my hand. It remained under cover of its box during the day, but toward sunset would leave its retreat and begin to run about the cage looking for food and clambering about, often hanging downward from the roof of the cage. It would not allow me to pick it up, but would voluntarily come to my hand and nibble it or take food from it. Various kinds of food were given it; cheese

and dry oatmeal were favorites. Among wild fruits none were eaten so greedily as the berries of the buck-bush (*Symphoricarpos symphoricarpos*). These berries are here the most important single article of diet for these mice in winter and also are eaten extensively by other mammals as well as by birds. Acorns were also readily eaten. Seeds of the redbud (*Cercis*), the wahoo (*Euonymus*), and the bittersweet (*Celastrus*) were eaten only when the articles of food above mentioned were lacking. Seeds of the scarlet sumac (*Rhus glabra*) were rejected entirely.

"A female with three young ate her offspring soon after being put in the cage, but the old one lived for several months. At one time, during my absence, she was without food, but ate the pasteboard box which served her for a home; she must have subsisted on this for at least a week.

"Two were taken about an old pond shortly after a period of exceptionally heavy rainfall. At this time salamander eggs had been deposited in abundance around the edges of ponds and the receding water left many of them stranded on the bank. The stomachs of both of the white-footed mice taken at this place contained some gelatinous matter which I could not positively identify, but which resembled the coating of salamander eggs more closely than any other substance apt to be found in such a place."

The nest is often made in a woodpile, although it is also placed under ground at times. It is composed of bark, small twigs, dry grass or leaves and lined with some kind of soft material. In construction it is very compact and resembles a bird's nest. Not infrequently an old bird's nest is used as a basis, and the mouse merely remodels and covers it.

The young are usually four or five in number, though sometimes as few as two or as many as six. They are naked and helpless when born, but grow rapidly and mature in about three months. Several litters are born each year, though I am unable to say how many.

After all our studies, we really know very little about the life history of our smaller mammals. How long do they live, provided they do not meet a violent death? If any die of old age, how are their last days spent? How are the offspring trained in the matters of food getting and nest building? These are some of the questions still unanswered for most of the smaller species. I have but a single observation on the life cycle of *Peromyscus*. On March 15 at Mitchell I saw a white-footed mouse come out of a woodpile in the bright light of midday and walk slowly and painfully toward

a hollow tree which was sometimes inhabited by these animals. I picked it up and it made no attempt either to escape or to bite, but cowered in my hand. It was evidently ill, and I put it in a cage, where it died within an hour. Dissection showed that it was an old male with worn teeth and that its stomach was gorged with food and congested with blood. There was no apparent source of poisoning, and I judge that the animal was attacked by some intestinal disease which acted rapidly and caused death, as it sometimes does in human beings. Epidemics are known to spread among various animals, but there was no evidence of an epidemic among the mice about here where I caught a number during the same month, and the cause of the death was apparently an individual malady.

The habits of these mice are affected in some parts of northern Indiana by the extensive swamps which cover a part of the region. Artificial drainage is rapidly altering conditions, but parts of the Kankakee valley were formerly overflowed to the width of from one to three miles during the spring floods. The white-footed mice inhabit these flooded forests and take refuge in the trees during high water. Their food supply is probably derived from stores which the squirrels have laid up in the hollow trees, with the addition of seeds which find lodgment among the branches, and is perhaps helped out also by tender twigs, buds and bark.

When high water continues for several weeks the supply of food must be very limited indeed, since the animals are restricted to a single tree or to several whose branches touch, because they can not leap from limb to limb like the squirrels. A hunter once told me that while he was eating his lunch, sitting on the trunk of a fallen tree surrounded on either side by a mile or more of water, a mouse came down a tree against which the fallen top rested, and after a number of panicky retreats, at last ventured to come up and nibble at some bread crumbs near the lunch box, which sat on the forks of the tree close to the hunter's legs. The animal was so nearly starved that its customary timidity was forgotten, and it no doubt considered the ample lunch which the hunter left for it as a fair reward for its boldness. Doubtless many mice die of starvation at such times, and some are probably drowned by the floods.

Economic status.—The white-footed mouse can not be considered beneficial from any standpoint, although it does eat a few insects. When it gets into fields of corn or small grain its destructiveness is equalled only by that of the house mouse and rat.

The most effective way of combating these mice is to keep fields and fencerows clean and free from brush and rock-heaps. They

seldom live in the clean, smooth pastures or meadows and never live in the cultivated fields unless they can find harboring places of some sort where they can make their homes. They are easily captured in ordinary mouse traps baited with cheese or dry oatmeal and set near the holes leading to their nests.

PEROMYSCUS MANICULATUS BAIRDI (Hoy and Kennicott).

PRAIRIE WHITE-FOOTED MOUSE.

Mus bairdi Hoy and Kennicott in Kennicott, U. S. Patent Office Report for 1856, pp. 92-95, Pl. XI, 1857.

Hesperomys michiganensis Baird, Mam. N. Amer., p. 476, 1857.

Calomys michiganensis Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 139.

Peromyscus michiganensis Allen, Bull. Am. Mus. Nat. Hist., Vol. VIII, p. 238, 1896.

Peromyscus maniculatus bairdi Osgood, N. Am. Fauna No. 28, p. 79, 1909.

Diagnostic characters.—Smaller and bluer (less brownish) than *P. leucopus* and with smaller ears and feet.

Description.—The color differences between *michiganensis* and *leucopus* are not easily described, but they are none the less evident. The duller color seems to be due, in part, to the greater number of plumbeous tipped hairs, in part to the fact that the other color is fawn rather than russet. The dark stripe along the middle of the back is also more plumbeous and this color is continued along the dorsal side of the tail. The tail is more thickly haired than in the common deer mouse and the dark color of the dorsal third is very sharply marked off from the white ventral two-thirds. The hind foot is shorter and more slender, an important character in distinguishing *michiganensis* from young leucopus, as the foot of a young mouse is proportionally larger than that of an adult, and the foot attains the maximum size before the animal is fully adult.

Measurements.—An adult female from Newton County measured 135 mm. (5 6/16 in.) in total length; tail, 60 mm. (2 6/16 in.); hind foot, 15 mm. (10/16 in.). The corresponding measurements of an Ohio County specimen were 137 mm. (5 7/16 in.); 57 mm (2 4/16 in.); 17 mm. (11/16 in.).

Skull and teeth.—The skull is both shorter and more slender than in *P. leucopus*, the incisive foramina are relatively wider,

being expanded posteriorly and the audital bullae are relatively wider. The teeth are narrower and the posterior upper molar is relatively smaller; coronoid process of the lower jaw is relatively stronger.

Range.—The range of this species includes part of Ohio, most of Indiana, Illinois and Wisconsin. The limits of its range are not well known. In their list of 1893 Evermann and Butler were unable to give any records of this species for the State, but put it in the list of whose which probably occurred. Since then it has been recorded by the writer from Newton County and by McAtee from Bloomington. I have also taken it at Bascom, Ohio County, and Chansler has taken two specimens at Bicknell, Knox County. Osgood also records it from Denver, Miami County. I know of no other records from the State, but these widely separated localities show that the species is of general occurrence and failure to report it from elsewhere is no doubt due, in part, to the fact that it is often confused with the young of *Peromyscus leucopus*, which it closely resembles.

Habits.—I have never obtained this species anywhere except in the thick bluegrass. Dr. Hoy stated many years ago that it was found only in the oak openings, but he seems to have held an erroneous idea concerning the identity of some of the mice which he collected, and the specimens from the prairies were not dissimilar to those from the open woods as he supposed. Indeed, the species is undoubtedly of prairie origin and it is doubtful whether it occurred in southern Indiana previous to the clearing of the forests.

Very little is known concerning the habits of this species. In general its habits are not dissimilar to those of *P. leucopus* when the latter species lives under the same conditions, as it sometimes does. The prairie white-footed mouse is a more delicate creature and it doubtless has a somewhat more restricted field of activity.

Genus Nyctomys Saussure.

Nyctomys Saussure, Revue et Magasin de Zoologie, 2d Ser., Vol. 12, p. 106, 1860.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{0-0}{0-0}$; M, $\frac{3-3}{3-3} = 16$.

Generic characters.—Size somewhat larger than the white-footed mouse, smaller than the house rat; body slender; tail very long; back bright reddish; under parts white.

This genus is indigenous to Mexico, Central America and north-

ern South America, where it is represented by some half a dozen species. Its inclusion in the Indiana fauna is made necessary by reason of its having been twice introduced into the State.

?NYCTOMYS DECOLORUS (True).

"RED RAT."

Sitomys (*Rhipidomys*) *decolorus* True, Proc. U. S. Nat. Museum, Vol. 16, p. 689, 1894.

Description.—Color rich reddish brown above; white on the underparts; tail very similar to the back in color both above and below; a dark ring around the eye; skull with strong supraorbital ridges.

I have no specimen before me as I write and this description is drawn from some hasty notes taken on a specimen in the State Musem at Indianapolis, supplemented by a reference to Dr. True's original description of the species *decolorus*. This specimen was captured in Indianapolis, May 1, 1903. Later in the same year an example of the same species was taken in Bluffton, Indiana, and sent to the National Museum at Washington, where it is retained in the collections as No. 122627. Concerning its identity Dr. M. W. Lyon, Jr., wrote me as follows: "The red rat belongs to the genus *Nyctomys* and may possibly represent the species *decolorus* True. * * * I am not at all sure. There are very few specimens of the genus in Washington, and none of them are authoritatively named excepting the type of *decolorus* which is a young thing and not much good, and a specimen of *sumichrasti*."

The species *sumichrasti* inhabits the state of Vera Cruz, Mexico, while *decolorus* is from Honduras. How these rats reached Indiana is a mystery. The one from Bluffton was caught in a grocery store and it seems probable that both may have reached here in a shipment of tropical fruit or other merchandise.

The fact that two of these animals should reach the State alive seems to indicate that some care is necessary to prevent the introduction of species of rats and mice which may become established and become a pest. This species is tropical and is not likely to be introduced in numbers sufficiently large to permit acclimatization. However, our experience with the house mouse, house rat, English sparrow and a horde of insect pests is such that we can not afford to take any chances, and strange rodents should be killed off with even greater care than our native kinds. Species of animals trans-

ferred from one locality to another often find a niche not occupied by the native fauna, and with the absence of natural enemies they may multiply very rapidly and become a serious pest.

Genus Microtus Schrank.

Microtus Schrank, Fauna Boica, Vol. I, 1st Abth., p. 72, 1798. Miller, N. Am. Fauna, No. 12, p. 9.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{0-0}{0-0}$; M, $\frac{3-3}{3-3} = 16$.

Generic characters.—Form thickset, with short, heavy legs, the hind pair of which are generally flexed at the ankle joint so that the body is carried close to the ground; head broad and blunt; eyes small, ears concealed by fur; tail always shorter than the body without the head, often much shorter.

The skull is broad, flattened dorsally, and strongly built. The upper incisors are never grooved; lower incisors long, the roots extending along the lower jaw almost to the angle, passing outside the last molar and inside the other two; molars with the enamel folded into loops which extend across the tooth, or triangles which have their bases along the middle line; molars with the bases the same shape of the crowns and not divided into prongs or roots.

The range of the genus includes most of the north temperate zone in both hemispheres. The mice of this genus are known as voles or meadow-mice. About 75 forms are known from North America and of these, four are found in Indiana. The Indiana species belong to three subgenera. They may be distinguished by the following key:

A. Tail short (less than 1 inch); color brownish with dense soft, velvety fur; mammae four; skull flat. (Subgenus *Pitymys*).
  B. Ear conspicuous above the fur; color dark rich brown; tail nearly one inch. *auricularis.*
  BB. Ear small; color dull brown; tail paler underneath than above. *scalopsoides.*
AA. Tail about an inch and a quarter or longer; fur coarse and grizzled; mammae more than four.
  B. Color dark brown, grizzled with black; tail about an inch and three-quarters; mammae eight. (Subgenus *Microtus.*) *pennsylvanicus.*
  BB. Color black and white or yellowish in a sort of pepper-and-salt mixture; tail less than one and a half inches; mammae six. (Subgenus *Pedomys*). *ochrogaster*

MICROTUS PENNSYLVANICUS (Ord.).

COMMON VOLE; MEADOW MOUSE.

Mus pennsylvanicus Ord., Guthrie's Geog., 2d Amer. Ed., Vol. II, p. 292, 1815.

Arvicola pennsylvanicus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 127.

Microtus pennsylvanicus Bailey, N. A. Fauna, No. 17, p. 16, 1900.

Diagnostic characters.—This species is distinguished from the other voles found in Indiana by its long tail. It is also of a darker brown color than any other species except *pinetorum*. The latter species has soft, dense fur and tail less than one inch in length.

Description.—The color of the back is dull dark chestnut, duller in winter than summer; under surface silvery gray with more or less of a brown tinge in some individuals; tail and feet about the color of the back or a little paler. The ear is distinctly visible above the fur, but low and rounded as compared with the white-footed and house mice; eyes small and bead-like; fur long and coarse.

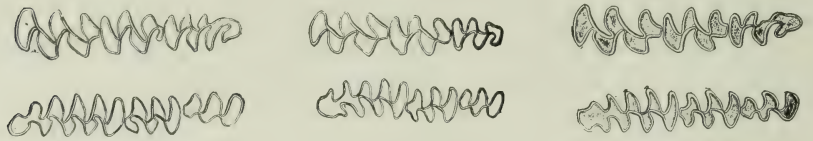


FIG. 8.—Crowns of the molar teeth of *Microtus*: a, Microtus pennsylvanicus; b, Microtus pinetorum; c, Microtus ochrogaster. After Bailey. North American Fauna No. 17, Bureau of the Biol. Surv., U. S. Dept. of Agri.

Measurements.—Ten specimens average: total length, 160 mm. (6 6/16 in.); tail, 42.3 mm. (1 12/16 in.); hind foot, 19.8 mm. (12/16 in.); greatest length of skull, 28 mm.

Skull and teeth.—The skull (fig. 9) is long and rather slender, but with widely spreading zygomatic arches; incisor teeth long, slender, light yellowish brown, projecting well beyond the skull proper. First lower molar (fig. 8a) with an anterior, foliated loop, a posterior transverse loop, and five closed triangles between them.

Range.- From the Atlantic coast to Dakota and from Canada south to the Carolinas. Its range, therefore, includes all of this State, but it can not be found in every locality. Evermann and Butler record it from Franklin, Carroll, Wayne, Vigo and Ran-

dolph counties. Other records are, Roselawn, Mountayr, Hebron, South Bend, Wolcottville, Bloomington and Bascom.

Habits.—In this State *Microtus pennsylvanicus* is seldom found at a distance from the marshes and streams and the common vole of most localities is *M. ochrogaster* or *Synaptomys c. stonei*. East of the Alleghenies the distribution is partially reversed and *Synaptomys* is always found in the bogs and swamps while the common meadow mouse, as it is there called, is found in the drier fields as well as the marshy places.

Along the Kankakee River, near Roselawn, I trapped industriously on a grassy sand hill above high water level and caught several species of small mammals, but no voles. Next I went down into an adjoining marsh that is covered with a growth of coarse

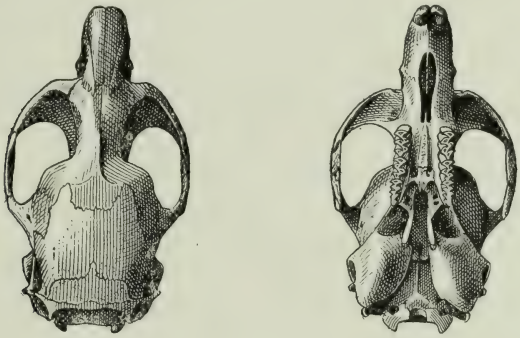


FIG. 9.—Skull of *Microtus pennsylvanicus*: a, dorsal view; b, ventral view. After Bailey. N. Am. Fauna No. 17, Bureau of the Biol. Sur., U. S. Dept. of Agri.

grass in summer, but is flooded with stagnant water during the spring. The grasses there grow up rank and fall down, become coated with a film of mud, and form a dense mat year after year. Under this mat of dead and decaying grass I found runways and caught the Pennsylvania vole in abundance. How do they get along in time of flood? Some retreat to the higher ground, no doubt, but some must be cut off by the water, for they go out into the marsh half a mile from higher ground; and half a mile is a long distance for these clumsy, slow moving little creatures. Are they able to swim out? Do they float down stream till washed ashore accidentally? Do they climb trees, or what becomes of them? These are questions I am not able to answer.

We do know that these mice can swim short distances and do

not hesitate to take to water. I have found their runways elsewhere in boggy places, running along under the dry grass for some distance, then going through underground tunnels filled with water, and perhaps leading to a nest under some upraised hummock. I have never found the mice at home in such a place, but there is strong evidence that they do at times occupy nests that can be reached only by swimming through tunnels that are filled with water.

In the southern part of the State, where there are fewer marshes, they often live along the grassy banks that line the smaller streams. They are sometimes found under corn and wheat shocks also, being therefore independent of the swamps; but they are not the most common mice in such situations.

Their food is principally grass blades. In winter when green grass is scarce they can subsist on the dried blades that they find under the snow, although tender green blades are not entirely lacking even then. The grass is cut away in a path just large enough for the animal to pass through comfortably and care is taken that it shall be where the long stems have fallen over so that they form a roof for the runway. These paths are extended nightly and often ramify and reunite in a bewildering maze of endless passages. However, the animals do not depend altogether on elongations of these pathways for their food. Often they find a bunch of particularly juicy grass and there they sit and eat their fill. Usually they are not "clean eaters," but leave sections of the grass blades, either because they are too tough or because it does not seem to the creatures profitable to pick up dropped food when there is so much at hand.

These mice will also eat grains and seeds, as their occasional presence under corn and wheat shocks testifies. However, I have examined the stomachs of a number of individuals, principally in August when both seeds and grass are plentiful, and have found that about 80 per cent of the contents was grass.

Butler and Quick state that this species breeds from February to December and that they never saw more than four young at a time. The only two pregnant females that I have taken contained two and four fetuses respectively. However it is known that six or more young are sometimes produced in a litter. The nest is made of dry grass and is often, though not always, placed underground.

Economic status.—This species is less injurious to farmers in Indiana than either of the other voles or the common white-footed mouse. Its habits of staying about marshy places renders it com-

paratively harmless both to meadows and to grains and vegetables. However, I know of no way in which it is useful unless it be in destroying a few weed seeds and an occasional insect. When it enters grain fields it may do considerable damage and it is always to be considered a pest that should be suppressed rather than a species to be protected.

MICROTUS OCHROGASTER (Wagner).

PRAIRIE VOLE.

Arvicola ochrogaster Wagner, Suppl. to Schreber's Säugethiere, Vol. III, p. 592, 1843.

Arvicola austerus Le Conte, Proc. Acad. Nat. Sci. Phil., Vol. VI, p. 405, 1853. Baird, Mammals N. Am., p. 539, 1857. Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 121.

Microtus austerus Bailey, N. A. Fauna, No. 17, p. 73, 1900.

Microtus ochrogaster Osgood, Proc. Biol. Soc., Wash., Vol. XX, p. 48, 1907.

Diagnostic characters.—Distinguished from other Indiana voles by the "salt and pepper" color of the fur of the back and the "ochery yellow" tinge which overlies the hair of both back and belly; size medium; tail one to one and a half inches.

Description.—Fur of back plumbeous at base, the long coarse hairs being dark throughout their entire length while the shorter fur is banded with black and gray or buffy. Sometimes the pale band is decidedly brownish and the animal resembles *M. pennsylvanicus* slightly. The sides are paler and the hairs of the belly lack the black bands, but are plumbeous at the base and gray or fulvous at the tips. There is considerable variation in the color and certain specimens from Laporte in the collection of the Field Museum have less of the yellow tinge than most of those from southern Indiana. I am unable to state, however, that these differences are more than individual variations. The tail is slender, the same color as the back above and very nearly white below. Feet pale; a yellowish ring about the eye in most individuals.

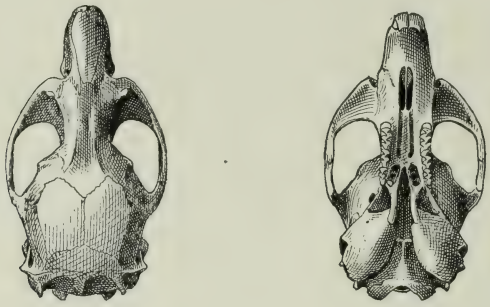
Measurements.—Ten specimens from Mitchell average as follows: Total length, 143.6 mm (5 12/16 in.); tail, 35.7 mm. (1 7/16 in.); hind foot, 19.7 mm. (13/16 in.).

Skull and teeth.—The skull (fig. 10) is long, narrow and rounded as compared with other species of *Microtus*. The molars (fig. 8c) have wide spreading, re-entrant angles. The first lower molar

has three closed and two open triangles besides a transverse loop at each end; the second has the anterior triangles confluent, followed by two closed triangles and a transverse loop; the third has three transverse loops.

Range.—The prairie vole has a range extending from Oklahoma and Nebraska to Ohio. Its range thus covers the whole of Indiana, though it does not seem to occur everywhere in the northern part of the State. Localities are Laporte, Putnam County, Vigo County, Bloomington, Mitchell, Wheatland, Bicknell, southwestern Knox County, Bascom, Franklin County.

Habits.—This species is the most common vole of the upland fields in southern Indiana. Its habits there are similar to those of its cousin, *Microtus pennsylvanicus,* of the lowlands. I have



a b

FIG. 10.—Skull of *Microtus ochrogaster*: a, dorsal view; b, ventral view. After Bailey. N. Am. Fauna No. 17, Bureau of the Biol. Sur., U. S. Dept. of Agri.

seldom seen it far from fence rows, old pastures or meadows where the grass grows thick and tall and forms the roof and walls of the runways made by these mice. It is active and feeds principally in the day time, although it also runs about more or less during the night.

From its runways it sometimes extends its activities to fields of grain. It is very fond of wheat when it is just ripening and has an ingenious method of getting at the heads. The stalks are not stiff enough for the mice to climb and interference with other heads prevents the wheat from falling over when the stalk is cut at its base. Therefore, the mice raise themselves on their haunches and cut the stalks as high as they can reach and when the cut end falls to the ground they cut off another section three or four inches long and repeat the process until the head is in reach. This work has been attributed to *M. pennsylvanicus,* and that species may be

guilty also, but I have caught the prairie vole near freshly cut stems when none of the other species were to be found in the locality. Wild seeds and berries are eaten also, but the principal food of this species is grass.

The nest is of dry grass and is placed under ground or under a protecting log or rock. One that I found was in a little depression under a discarded railroad tie lying on the side of an embankment. At the time of discovery, about 4 p. m. on April 11, the mother was not at home, and I carefully replaced the tie over the nest containing three hairless and blind young. Early the next morning the old mouse was again absent but about ten o'clock I found her nursing her offspring. She began to run with the young still clinging to her teats, but the whole family was captured. They were confined in a roomy wire cage with plenty of dry grass and cotton for a nest and fresh grass, bread and water for food. Nevertheless, the next morning the cage contained only the mother; she had eaten her children. The old mouse lived only two days longer. She showed a surprising ability to climb, not only going up the sides of the cage, but creeping, fly-like, across its wire top with her claws hooked in the meshes of the wire and her body hanging downward.

The breeding habits are very much like those of *Microtus pennsylvanicus*. I have caught young almost four inches in length on April 2d; they must have been born about the first of March. Pregnant females have also been found in September and the breeding season evidently includes all of the summer months, though I am positive that they do not, as a rule, breed between October and February. Sometimes they mate as soon as the litter of young is born. The period of gestation is short, probably not over three weeks. I have never found more than four young in any litter. Two and three at a birth are quite usual. Miller states that the number of mammae is four, but he evidently erred, for Bailey gives the number as six, and all that I have examined when the mammae were in condition to be distinctly seen, had six. This would seem to indicate that more than four young are sometimes produced at a time.

Economic status.—In the southern part of the State, at least, this species is more destructive to crops than the preceding one, but less so than the following; the white-footed mouse or the house mouse. Its work is confined chiefly to places that can be easily reached from fields or fence rows that are overgrown with grass, weeds and bushes. Therefore, a very effective way of ridding a

farm of the mice is to keep it free from rank grass, weeds or bushes. They are easily caught in traps set in their runways and baited with dry oatmeal, nuts, cheese or even bread or grain. Occasionally they damage orchards by stripping the bark from the young trees in winter. However, the prairie vole is not the worst offender in this respect.

MICROTUS PINETORUM AURICULARIS Bailey.

BLUE-GRASS VOLE.

Microtus pinetorum auricularis Bailey, Proc. Biol. Soc. Washington, Vol. XII, p. 90, 1898. N. Am. Fauna, No. 17, p. 65, 1900.

Arvicola pinetorum Evermann and Butler (part), Proc. Ind. Acad. Sci. for 1893, p. 127.

Diagnostic characters.—Distinguished from all the other mice of this family except *Synaptomys* by its short tail (less than one inch). From *Synaptomys* it is distinguished by being brown in color instead of gray, and in having slender upper incisors without grooves down the front.

Description.—The chief difficulty in identifying this mouse is in separating it from the next subspecies to which it is closely related and the two forms are therefore compared here, the characters being taken principally from Bailey. Upper parts dull brownish chestnut in *scalopsoides,* not always darker, but always richer and more intense in *auricularis;* tail indistinctly bicolor in *scalopsoides,* being sooty above and grayish below; scarcely darker above than below in *auricularis.* Feet brownish gray in *scalopsoides;* dull brown in *auricularis.* Ears scarcely visible above the fur in *scalopsoides;* distinctly projecting in *auricularis.* Average measurements of *scalopsoides* from the type locality (Long Island, New York), total length, 125 mm.; tail, 20 mm.; hind foot, 16.3 mm.; of *auricularis* from the type locality (Washington, Mississippi), total length, 119 mm.; tail, 22 mm.; hind foot, 17 mm. The skull is also slightly larger and the tooth row longer in *scalopsoides.*

The fur of these mice is soft and velvety and there are no coarse hairs. Their eyes are also smaller than those of the two preceding species, and they are better adapted to the underground life, which they seem to prefer. There are but two pairs of mammae, both in the inguinal region.

Specimens from Bascom, Mitchell and Bicknell have been as-

signed to the subspecies *auricularis* rather than *scalopsoides*, because their colors are darker and richer and the ears more prominent than on specimens from Maryland, which are assumed to be fairly typical of *scalopsoides*. Bailey in his revision of the genus has assigned some Brookville specimens to each form.

Measurements.—Full grown specimens from Mitchell vary 17 mm. in total length and 2 mm. in length of hind foot. The average of five specimens from this locality is: Total length, 119.2 mm. (4 13/16 in.); tail 18.6 mm. (12/16 in.); hind foot, 15.8 mm. (10/16 in.). Five from Bascom are slightly larger. Cranial measurements of four from Mitchell: Greatest length of skull, 25.8 mm. (1 in.); basilar length, 21.2 mm. (14/16 in.); palatilar length, 12.8 mm. (½ in.); greatest width of braincase, 12.2 mm. (½ in.); depth of braincase over audital bullae, 15.5 mm. (7/16 in.); maxillary tooth row, 6 mm. (¼ in.).

Skull and teeth.—As compared with other species of *Microtus* the skulls of *pinetorum* (fig. 11) and its subspecies are flat and

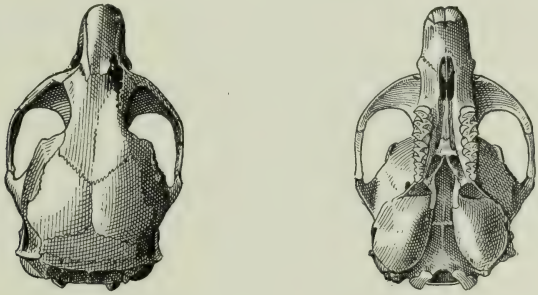


FIG. 11.—Skull of *Microtus pinetorum*: a, dorsal view; b, ventral view. After Bailey. N. Am. Fauna No. 17, Bureau of the Biol. Sur., U. S. Dept. of Agrri.

wide, with a quadranguar braincase, wide interorbital space and short rostrum. The molars are narrow, the loops and triangles are essentially as in *Microtus ochrogaster*, although they differ in proportions, the most apparent difference being in the posterior upper one. (See fig. 8b.)

Range.—The bluegrass vole occupies the region between the Allegheny Mountains and the Mississippi River south of the Ohio River, and extending north of the latter into southern Indiana and Illinois. Other subspecies are found to the north and east. Indiana records are Brookville, Bascom, Mitchell and Bicknell.

Habits.—As mentioned above, this species lives underground most of the time. Unlike all of the other voles which live almost exclusively in the grass, this one is more abundant in the woods, although found in fields also. Since it lives under ground and is not dependent on the overhanging grass for its protection, it is found in cultivated fields, gardens, orchards, lawns and meadows. In such places it rarely comes to the surface and is difficult to trap, because it closes up an opening made into its burrow instead of coming out to get the bait placed for it.

The tunnels which it makes, like those of the mole, are marked by lines of upheaved earth. How it makes them I do not know, for it has neither the powerful, shovel-like feet nor the pointed nose which so admirably fit the mole for its work. No doubt it sometimes uses tunnels already made by the moles or by the short tailed shrews. However, if it uses the runways of the shrews it does so at the risk of its life, for these fierce little animals run down and kill the mice and devour them greedily.

The mice get even with the order Insectivora, in a measure, by doing immeasurable mischief for which the moles and shrews get the blame. The latter animals are chiefly insectivorous and do good by eating cut-worms, grubs, beetles, flies or any other insects they can get. On the other hand the mice eat roots, bulbs, seeds and bark and are sometimes a serious pest on the farm; but the moles get the blame for eating newly planted corn and garden vegetables which they have not touched.

Young orchards are often badly damaged by these mice, which not only cut or peel the slender roots of the trees, but also strip the bark from the bases of the trunks. I know of a young orchard in which the trees were protected in winter by a heap of coarse manure and stalks about the base. When it was removed in the spring half of the trees were partially or wholly girdled and many of them died. The farmer attributed this to the ferments in the manure, but this was so coarse that I am sure it did no harm, and firmly believe the mice had been working on the trees, their tooth marks being so fine that they were overlooked. It is known certainly that this species has been guilty of similar work elsewhere.

Aside from cultivated plants, the mice of this subgenus live principally on roots. Butler and Quick found them storing up the tuberous roots of the wild violet in underground heaps of a gallon or more. Like the other voles, they are also fond of the stems and leaves of tender green plants. Where their tunnels are

in the fields, there is often an opening here and there, with the grass blades near it clipped close to the ground. Sometimes in walking quietly through the woods you may hear a dead leaf rustle as though moved by the wind. If you look quickly and keenly toward it you may distinguish a brown head, set with two tiny, bead-like eyes, disappearing into a hole under the leaves. If you examine the place closely you will probably find the entrance to the labyrinthian tunnels of these mice and very likely you can also find where the animal has been cutting the stem of a green violet or some other tender plant.

The nest is always placed under ground or under an old stump or log and is made of fine, dry grass, root fibers or leaves. All the breeding females that I have seen had two, three or four young, and as they have but four teats the latter number would seem to be the maximum for the species.

Economic status.—This is the most destructive of our native mice and it is the greater pest because it is not often seen and is almost unknown to the farmer. Most often it is the species guilty of throwing up the dirt into the bases of wheat and corn shocks, and coming up through a small, obscure hole to eat the grain. It may not be the only offender in this respect, but it is quite agile in escaping into its runway while the other voles and the white-footed mice often run away on top of the ground.

The injury which this species does in orchards has already been referred to. I have also known them to eat sweet potatoes and white potatoes from the rows, and to follow along corn rows and eat the sprouting grains.

Since they live in cultivated fields and under ground, they can not be driven away by keeping down weeds and grass, although they are not as abundant in a clean field as in one overgrown with weeds and bushes. They can be trapped if some care is taken to find openings which they themselves have made from their tunnels. If the latter are dug open, a trap placed in them is apt to be pushed aside or covered with dirt. Strychnine or arsenic make good poisons, and grain soaked in a sweetened solution of either of these poisons and dropped into holes made in the roof of their tunnels is very effective. Where there are stumps or logs or brush heaps that can be overturned quickly, the mice can often be caught by hand, and clearing a field of such shelters is not without its effect in lessening their numbers.

MICROTUS PINETORUM SCALOPSOIDES (Audubon and Bachman).

MOLE MOUSE.

Arvicola scalopsoides Audubon & Bachman, Proc. Acad. Nat. Sci. of Phil., Vol. I, p. 97, 1841.

Arvicola pinetorum Evermann & Butler (part), Proc. Ind. Acad. Sci. for 1893, p. 127.

Microtus pinetorum scalopsoides Bailey, N. A. Fauna, No. 17, p. 64, 1900.

(For diagnosis, description and measurements see the preceding species.)

Range.—This subspecies extends from southern New York to Illinois, with a more northern range than the preceding. Indiana localities are: Terre Haute, Brookville, Randolph County, Wabash County. The last two records are from Evermann and Butler, and are assigned to this subspecies for geographic reasons. I have never taken these mice in the northern part of the State, and have no measurements of my own.

Remarks.—Admitting two subspecies of this group of mice to the Indiana fauna is made necessary by Bailey who, in his revision of the genus, records the two forms from Brookville. Such a procedure may be necessary to the systematist who wishes to assign all of his specimens to one form or another, and at the same time be consistent in observing the characters which define the forms; but it is wholly at variance with the true conception of species and subspecies. If subspecies are to be considered as all derived from an ancestral form by a process of variation, the variations becoming fixed by climatic or other direct influences, or geographic isolation, it is unthinkable that two of these subspecies should be found in the same locality. It is conceivable, of course, that where they intergrade there should be a neutral zone in which some individuals should be like one and some like the other subspecies, but these are all neutrals or else the forms do not intergrade and hence are not subspecies. The Linnaean system of nomenclature is inadequate to express such relations.

It should be stated that the same differences which Bailey recognized in Brookville specimens are to be seen in those collected at Mitchell. Number 150, author's collection, is small and of a rich glossy brown color as found in *auricularis.* Number 259 is decidedly larger and duller as in *scalopsoides,* and there are other specimens showing the same differences.

Habits.—The habits are not known to differ materially from the other form.

Genus Fiber Cuvier.

Fiber Cuvier, Lefons d'anat. comp., Vol. I, tabl. 1, 1800.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{0-0}{0-0}$; M, $\frac{3-3}{3-3} = 16$.

Generic characters.—Distinguished from all other members of the family by the large size and long tail, which is laterally flattened. The skull and teeth resemble those of some of the larger species of *Microtus,* but the molars are rooted.

The genus is limited to North America, and extends from northern Mexico to Labrador and Alaska. About ten species and subspecies are now recognized. Only one of these occurs in Indiana.

FIBER ZIBETHICUS (Linnaeus).

MUSKRAT.

[*Castor*] *zibethicus* Linn., Syst. Nat. Ed. 12, Vol. I, p. 79, 1766.

[*Fiber*] *zibethicus* Cuvier, Règne Animal, Vol. I, p. 192, 1817.

Fiber zibethicus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 126.

Diagnostic characters.—Those of the genus.

Description.—Fur of two kinds, an overfur of long, moderately coarse hairs, and a dense underfur of wooly hairs. The color is dark glossy brown above, with the sides tinged with yellowish and belly dirty, yellowish white; upper lip yellowish. Hind feet very broad, with the toes joined together by a web; ankle joint so constructed that the feet can be turned edgewise during the forward stroke of the foot in swimming.

The whole structure is a very perfect adaptation to aquatic life. The tail acts as a rudder in the water; the feet make very effective propellers; and the fur is a water-proof covering through which no moisture penetrates.

Measurements.—An adult female from the Kankakee near Hebron measured 640 mm. (25 10/16 in.) in total length; tail, 290 mm. (11 10/16 in.); hind foot, 75 mm. (3 in.).

Skull and teeth.—The skull resembles that of the species of *Microtus* in general appearance but, of course, is much larger, The braincase is quadrangular as in *M. pinetorum,* but is not so flat and the rostrum is proportionally longer. The roots of the lower incisors are outside the roots of the molars.

Range.—The typical form is found from southern Canada to southern Virginia and the Gulf States and west to at least the Rocky Mountains. It is found in this State wherever there are suitable bodies of water.

Habits.—It seems to me the word "versatile" is appropriate in describing the habits of this animal. With habits in the primeval state essentially like those of the beaver, the muskrat has thrived and multiplied with the settlement of the country, whereas the beaver disappeared early before advancing civilization.

Although the valuable fur of the beaver aroused the greed of man to a greater extent than the more humble coat of the muskrat, the latter animal has been trapped, shot and otherwise persecuted almost incessantly. Nevertheless he has profited by the destruction of his natural enemies and he has taken advantage of artificial ponds and canals to extend his habitat. He has even been able to maintain a somewhat precarious existence along the streams within the limits of the larger cities. In his quest for food, he sometimes follows cellar drains and reaches the winter supply of vegetables, thereby putting himself on a par with his despicable cousin, the house rat. But it must be said that such offenses are infrequent.

Where they have an extensive tract of water and are not too much disturbed, the muskrats build houses similar to those of the beaver. Mr. Butler has given the following description of one which was built on a marshy peninsula projecting into a stream near Brookville. "The house was composed chiefly of swamp grass, sedge, coarse weeds and mud, while fresh water algae, small pieces of drift, a few pieces of shingle and two staves were found among the more common material. The greater part of the mud was in the lower part of the house, and I think it was mostly brought in attached to the roots of grass. The ground in the neighborhood of the house was cleared of all vegetation, even of roots, for some distance. The house was nicely thatched with weeds and sedge.

"The ground plan was oval in outline, four feet six inches wide and six feet three inches long. On the land side the house was two feet six inches high, and on the water side three feet four inches. The whole presented the appearance, in miniature, of an oblong hay rick. The inside was quite irregular. Measurements at the bottom of the chamber showed the greatest length to be 22 inches, the least 12 inches, with an average width of 16 inches. The greatest height, measuring from the surface of the stream, was one foot. Six inches from the bottom, a shelf was found running from the left of the entrance and above the top of the water. This shelf was 12 inches long and eight inches wide, and ranged from six to eight inches in height. It was arched over very neatly with

drift and coarse weeds. At a point farthest from the center of the chamber, immediately over the shelf, was a passage leading upward toward the side of the house. While it did not penetrate the wall, it passed through the more compact portion and enabled the inmates to obtain air. Entrace was had through a covered way, from and beneath the water to the center of the house, where it terminated in a mass of fine grass and mud, through which there was a funnel-shaped opening to the interior.

"This house was completely destroyed, and within a week the muskrats had erected a new one on the site of the old, similar to it but nearly twice as large, using the material of the old and clearing off the vegetation from a much larger space."

Where the muskrats live in thickly populated localities or along small streams they do not build houses, but make burrows beneath the water and there is also a vertical hole in the bank that leads down to the nest and supplies air to the inmate. The burrows sometimes extend back for many feet and the nest is generally placed about the high-water level of the stream.

Usually there is a place not far from the nest where the animals are in the habit of climbing the bank to search for food and where they return to the water. Trappers take advantage of these smoothly worn "slides" to set their traps. For, while it can not be said that the muskrat shows much ingenuity in avoiding traps, the uninitiated is very apt to meet with failure the first time he attempts to catch one. The animals do not often stumble blindly into a trap set on the bank, and if one does get caught in a steel trap so located, his first act is to brace himself with all his might and pull to get free. If the trap is weak and the animal full grown he may succeed. If not, he usually continues struggling and biting until he has either broken his foot off or else he bites it off below the jaws of the trap, where it is numbed by their pressure, and pulls out the stump and so escapes.

Accordingly experienced trappers place a steel trap in the water at the bottom of a "slide," where the unwary "rats" get in readily, and the chain is fastened by a stake set in deep water, so that the animal cannot get on the bank, and it is soon drowned by the weight of the trap. The "rats" are also speared in the houses during the winter.

Trapping muskrats for fur has been an important source of revenue to many men, especially in the marshes along the Kankakee River. A trapper who went to the Kankakee country in 1865 told me that at that time muskrat houses stood so thickly

in some places that it was possible to open three or four of their houses from an anchored boat. Mr. I. N. Lamb states that in 1871, after the Kankakee valley burned off, he sometimes caught more than eighty muskrats in a single night in his line of 100 steel traps. In the history of Lake County it is stated that the annual catch in that county alone, varied between 20,000 and 40,000 during all of the period from 1834 to 1884. In the Northwest territories of Canada, according to Macfarlane, more than 768,000 skins were taken by the Hudson's Bay Company in 1873, while in 1903 the number had reached 1,482,670.

In spite of this tremendous slaughter the species holds its own fairly well except where the habitat is reduced by drainage or where disease becomes prevalent, as it sometimes does. As recently as 1904 one trapper I know claims to have caught 300 "rats" in 30 days, trapping in the Kankakee in Newton and Lake counties. The same season another trapper took 700 of the animals during the fall and winter in Porter and Jasper counties. The average price of the skins is about 15 cents, the price varying in different years, and being higher for late winter than for fall skins.

The food of muskrats is quite varied. During the summer it consists principally of marsh grasses and other aquatic plants. When these become scarce in winter, the animals turn to any vegetable food at hand, and gardens and cornfields near their homes may suffer in consequence. At such times they also resort to animal food, and the fresh water mussels are often eaten. The shells can be cut with the powerful incisors of the rodents, and it is said that they have also learned to carry mussels out of the water and lay them on the bank, where they die and are then opened easily with the paws.

Butler states that the number of young is usually from four to six, but Macfarlane says that from eight to twenty are produced at a time in Canada. The adult females usually produce three litters a year, the young being brought forth between March and September in grass-lined nests in the tunnels that lead into the banks of the streams.

Economic status.—As shown above, the muskrat may be a source of income to a considerable number of people. If the figures given above for Lake County are correct, the residents of that county made four or five thousand dollars annually from the muskrat hides in the fifty years preceding 1884.

The injury which these animals do to crops is negligible, since

their aquatic habits usually keep them from cultivated fields. However, they sometimes do considerable damage to ditches, ponds and railway embankments near the water by digging into the banks. These holes are enlarged by action of the water, especially if there is a current, and they may cause the embankment to break. Mr. Butler states that a trench of gravel through the bank or a dressing of gravel or cinders on the surface of the embankment will keep the animals from digging into them, and keeping them free from vegetation also keep the rodents away. They are sometimes supposed to destroy fish, but this is seldom or never the case.

If they become troublesome, they are easily caught in traps by the method previously described. It is also easy to poison them with apple, turnip or cabbage poisoned with strychnine and dropped near their dens.

Genus Synaptomys Baird.

Synaptomys Baird, Mamm. N. America, p. 558, 1857.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{0-0}{0-0}$; M, $\frac{3-3}{3-3}=16$.

Generic characters.—Form like that of *Microtus*, the tail being shorter than in most species of that genus. Upper incisor broad, with distinct grooves down their anterior faces; lower incisors with the roots inside the molars; molars rootless (without prongs);

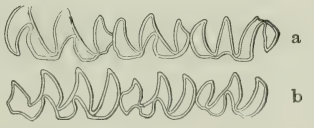


Fig. 12.—Enamel pattern of molar teeth of Synaptomys: a, upper molars; b, lower molars. After Miller. N. Am. Fauna No. 12, Bureau of the Biol. Sur., U. S. Dept. of Agri.

the posterior upper one with four transverse loops differs markedly from the corresponding tooth in any species of *Microtus*. (See fig. 12.)

The genus is limited to North America north of the gulf states. About ten species and subspecies are known, only one of which is found in our State.

SYNAPTOMYS COOPERI STONEI (Rhoads).

THE STONE LEMMING MOUSE.

Synaptomys stonei Rhoads, Amer. Nat., Vol. 27, p. 53, 1893.

Synaptomys cooperi Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 126.

Synaptomys cooperi stonei Rhoads, Proc. Acad. Nat. Sci. Phil. 1897, pp. 305, 392. Hahn, Proc. U. S. Nat. Mus., Vol. 32, p. 460, 1907.

Diagnostic characters.—Color above, brownish gray; form squat and heavy; tail less than one inch; upper incisors grooved.

Description.—The shade of color varies considerably. In individuals in summer pelage the color is decidedly rusty, the short fur of the back being all tipped with ferruginous, which the long overfur partly conceals. The winter specimens usually are paler, the tips of the short fur being cinnamon or fulvous. The sides are paler and the belly is pale slate color, with the plumbeous bases of the hairs showing through more or less. Throat and underlip of some individuals white, of others slate.

The status of the various names that have been given to different forms of *Synaptomys,* and the relationships of these forms has not been satisfactorily determined. The history of some of these names, together with reasons for adopting *stonei* as the name for the Indiana form of the lemming mouse, has been given by the author (Proc. U. S. Nat. Mus., Vol. 32, pp. 460-461), and he has seen no reason to change his conclusions. Since that time he has collected lemming mice on the Missouri River in South Dakota, which are apparently the form *gossi* and differ markedly from the Indiana specimens in being much larger and clumsier, with larger and heavier skull.

Measurements.—Ten specimens from Mitchell averaged 113.2 mm. (4 8/16 in.) in total length; tail, 18.5 mm. (12/16 in.); hind foot, 17.2 mm. (11/16 in.); ear from crown, 9 mm. (6/16 in.). Three from Wolcottville, Lagrange County, average, total length, 114.3 mm.; tail, 20 mm.; hind foot, 16.3 mm.

Skull and teeth.—The skull of the Indiana *Synaptomys* is intermediate in size between that of the typical species (*cooperi*) from the east and that of the species *gossi* from the plains region. The general features of the skull are given under the diagnosis of the genus. Average measurements of ten skulls from Mitchell are: Greatest length, 26 mm.; palatilar length, 12 mm.; greatest width of braincase, 12 mm.; depth of braincase over bullae, 9.6 mm; length of molar tooth row, 6.8 mm.

Range.—From southern New Jersey to Indiana; the limits of the range are not known. In this state it seems to be of common occurence in all sections. Records are: Roselawn, Hebron, Wolcottville, Nashville, Brookville, Bascom, Bloomington, Mitchell.

Habits.—East of the Alleghenies the lemming mice are found only in sphagnum bogs and swamps. In Indiana I have but a single specimen recorded from a swamp. That one was taken in a tamarack swamp near the Lagrange-Noble County line east of Wolcottville.

At other places they seem to be confined to areas covered with dense blue grass. Their habits there are similar to those of the prairie vole and the two species are often found together; whether they live in harmony I do not know. Butler and Quick say of it that it prefers open woods pastures where there is little undergrowth. They state that it is the most active of our mice and is off like a flash if disturbed when under cover.

These authors are mistaken in saying that the nest is always placed under cover. I have found a conical nest ten inches in diameter and five inches high placed on the ground with no covering except a very thin veil of dry grass blades. It was inconspicuous, however, for it was made of moss and grass and placed in a hummocky place among some sumach bushes. The lining was of fine, dry grass.

Inside were four little mice about two and one-half inches long, with open eyes and body fully covered with hair. I took them to the house, made a warm nest for them and began to feed them milk with a pipette. They seemed to thrive for two days, then all died suddenly. An old mouse, apparently their mother, was caught at the site of the nest. She would have given birth to five more young in a week or ten days. The usual number of young at a birth seems to be four, but three and five are not infrequent.

These mice live on grass more exclusively than any other species that I know. However, they sometimes eat seeds and roots, and like some species of *Microtus*, sometimes store up supplies in the winter. Butler and Quick state that they sometimes store up large quantities of the roots of the wild artichoke (*Helianthus*).

Economic status.—No doubt this species, like all other members of the family, sometimes does damage to grain and vegetables. But of this I have no direct evidence, for I have never caught the species in cultivated fields nor do I know that it has ever been taken in such places.

Family GEOMYIDAE.

POCKET GOPHERS.

Form adapted for underground life, with short, strong legs, front feet armed with powerful claws, hind feet also strong, tail short, ears and eyes small, and incisors long and strong. The skin of the cheeks is folded inward, forming pouches which reach from the mouth to the shoulder inside of the outer skin, the opening of these pouches being outside of the mouth.

The family is limited to North America, where it is represented by several genera and a number of species. A single genus is found east of the Mississippi.

Genus GEOMYS Rafinesque.

POCKET GOPHERS.

Geomys Rafinesque, Am. Month. Mag., Vol. II, No. 1, p. 45, 1817.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{1-1}{1-1}$; M, $\frac{3-3}{3-3} = 20$.

Generic characters.—Upper incisors, with two grooves, a small one near the inner or midle edge of the front and a deeper one near the middle. Premolar in each jaw with a constriction which makes the enamel pattern the shape of a flattened figure 8. Other molars simple and without any marked constrictions or folds. Skull with a triangular braincase and prominent processes (mastoid processes of the squamosal and bulla) for the attachment of the muscles used in mastication; region between the eyes constricted; rostrum long and subcylindrical.

Form short and stout; eyes and ears small; tail short; nearly naked and extremely sensitive to touch. Claws of fore feet extraordinarily long and strong. Large pouches opening beside the mouth into the cheeks.

The genus contains about 15 species and subspecies in the plains region of the United States and Canada, and with two or three isolated forms in Georgia and neighboring States. But one species is found in the central states east of the Mississippi.

GEOMYS BURSARIUS (Shaw).

EASTERN POCKET GOPHER.

Mus bursarius Shaw, Trans. Linn. Soc. of London, Vol. 5, pp. 227-228 and Pl. 5, 1800.

Geomys bursarius Merriam, N. Am. Fauna, No. 8, p. 120, 1895. Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 126,

Diagnostic characters.—The generic characters distinguish the species from all other mammals found in the State.

Description.—The color is described by Merriam as "dark liver brown or chestnut above and below, somewhat paler on the belly; fore feet white; hind feet soiled white; hairs of tail usually brown on basal part and white on terminal part." The form is indicated by the generic description.

Measurements.—Dr. Merriam gives the following measurements as the average of 68 specimens: Total length, 274 mm. (11 in.); tail, 76 mm. (3 in.); hind foot, 33 mm. (1 5/16 in.). No measurements of Indiana specimens are at hand.

The skull and teeth are sufficiently characterized under the description of the genus.

Range.—From the Canadian border in North Dakota to southeastern Missouri and east to northwestern Indiana. Indiana marks the eastern limit of its range, and it is not generally distributed in this State. I have never collected it in Indiana nor do I know of any specimens from this State in collections, but there is no doubt of its occurrence in Lake and Newton counties. The only definite records I have are Shelby, Lake County, and Lake Village, Newton County.

Habits.—The gophers are burrowing animals and spend all of their time underground excepting in late summer and autumn, when they are said to sometimes wander about in search of new locations. The mole thrusts its pointed nose into the earth and heaves upward, at the same time thrusting his broad front feet forward and pushing to one side. In this way he lifts the dirt upward all along his path, and is saved the trouble of carrying it. But the gopher laboriously breaks the dirt loose with his powerful incisors and claws and, when he has accumulated a heap, places himself behind it, making a scoop of his forelimbs, and pushes it along the already completed part of his tunnel to an opening and there heaves it up to the surface. The work is very rapid, however. These gopher hills sometimes contain a bushel or more of earth and they are the only indications we have of the presence of the animals; they leave no mark along their pathway as the moles do.

In his work of excavating, the gopher moves back and forth in his tunnel like a shuttle engine, without turning around. The tail serves as an organ of touch in the backward progression, being rather short and fleshy, and is carried straight behind the animal.

In some text-books of zoology we find it stated that the pouches

are filled with earth which is thus carried out to the surface and emptied. According to the observations of Merriam and Schaeffer, this statement is erroneous, and the dirt is always moved by placing the fore legs behind it and pushing with the hind legs.

The cheek pouches differ from those of the ground squirrels in opening outside of the mouth and in being lined with fur on the inside. Their only use is for carrying food to the store houses, which always contain a larger supply than the animal can possibly use. The pouches can be turned wrong side out without injury, and it is said that they are sometimes thus everted when the animals are frightened by a snake.

Dr. Merriam thus describes the way in which the pouches are filled and emptied: "A piece of potato, root or other food is seized between the incisor teeth, and is immediately transferred to the fore paws which are held in a horizontal position, the tips of the claws curving toward one another. If the food requires reduction in size, the trimming is done while held in this position. The piece is then passed rapidly across the face with a sort of wiping motion which forces it into the open mouth of the pouch. Sometimes a single rapid stroke with one hand is sufficient; at other times both hands are used, particularly if the piece is large. In such cases the long claws of the one hand are used to draw down the opening, while the food is poked in with the other. It is obviously impossible for the animal to pass food from the mouth to the pouches without the aid of its fore claws.

"The most remarkable thing connected with the use of the pouches is the way in which they are emptied. The fore feet are brought back simultaneously along the sides of the head until they reach a point opposite the hinder end of the pouches; they are then pressed firmly against the head and carried rapidly forward. In this way the contents of the pouches are promptly dumped in front of the animal. Sometimes several strokes are necessary. I am not prepared to say that the animal can not empty the pouches by means of the delicate investing muscles, but I have never seen them emptied in any other way than that here described."

The food consists almost wholly of roots of various kinds. In their native state, the gophers live almost wholly on the roots of the prairie grasses and other prairie plants. With the introduction of cultivated plants into their range they have found many of them more desirable food. Potatoes and garden vegetables are often eaten. Roots of fruit and other trees are sometimes cut off to such an extent as to almost destroy an orchard. But the food

which they consider peculiarly fitted for themselves is the large, succulent roots of the alfalfa.

Pocket gophers apparently breed but once a year, the young being born in March and April. There are usually three or four in a litter, but there may be as many as six. They are born in a nest of fine grass placed in a lateral passage of the main burrow, and do not reach maturity till the end of the summer, when they begin to shift for themselves.

Economic status.—In this State the pocket gophers are too rare to do much harm. But in many localities farther west they have caused serious losses to farmers, gardeners and fruit growers. They can be caught in small steel traps placed in the bottom of their tunnels, or in special gopher traps. The animals always close every hole through which light enters and a small opening near the trap takes the place of bait. They can also be poisoned with strychnine placed in potato or dried fruit and dropped through a small opening into the tunnel.

Family ZAPODIDAE.

JUMPING MICE.

Dipodidae Flower and Lydekker, Introduction to the Study of Mammals, pp. 479-480, 1891. Miller and Rehn, Proc. Bost. Soc. Nat. Hist., Vol. 30, p. 166.

Zapodidae Lyon, Proc. U. S. Nat. Mus., Vol. 23, pp. 659-668.

Hind feet much elongated; metatarsal bones five in number and separate (not united into a cannon bone); no cheek pouches; tail very long.

The family is not easily confused with any other American rodents. The kangaroo rats, which resemble the jumping mice in form and inhabit southwestern North America, are distinguished by the presence of external cheek pouches like those of the pocket gophers. This family is distinguished from some of the old world jumping mice by a number of osteological characters.

Genus ZAPUS Coues.

Zapus Coues, Bull. U. S. Geol. Surv., Terr., Vol. I, 2d Ser., No. 5, p. 253, 1875. Preble, N. Amer. Fauna, No. 15, 1899.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{1-1}{0-0}$; M, $\frac{3-3}{3-3} = 18$.

Generic characters.—Upper incisors with grooves on their anterior faces; deep orange in color; premolar small and cylindrical; molars with somewhat complicated and crowded folds of enamel.

Skull (fig. 13) rather high and rounded, similar in shape to the skull of the house mouse except that it is more arched in the interorbital region. Body largest posteriorly. Hind legs and tail very long.

About 18 species and subspecies are known from North America and at least one is found in China. A single form occurs in Indiana.

ZAPUS HUDSONIUS (Zimmerman).

HUDSON BAY JUMPING MOUSE.

Dipus hudsonius Zimmermann, Geog. Geschichte, Vol. II, p. 358, 1780.

Zapus hudsonius Coues, Bull. U. S. Geol. Surv. Terr., 2d Ser., No. 5, p. 253, 1875.

Zapus hudsonicus Evermann and Butler, Proc. Ind. Acad. Sci for 1893, p. 125.

Diagnostic characters.—Size of body approximately that of the house mouse; hind feet and tail very much longer; color a bright yellowish, not unlike that of the white-footed mouse in winter pelage.

Description.—The upper parts are yellowish fawn color or dark ochraceous and this is overlaid by a number of long hairs with darker tips. In a line down the middle of the back, these dark tips predominate and form a dark stripe reaching from the head to the base of the tail. This dark stripe is not so distinct in the fall and early winter. The belly and feet white or slightly yellowish.

Measurements.—Measurements of Indiana specimens are not at hand. Preble, in his revision of the genus, gives the following measurements as the average of eleven specimens from Tower, Minnesota: Total length, 219 mm. (8 12/16 in.); tail, 133 mm. (5 5/16 in.); hind foot, 30.2 mm. (1 3/16 in.).

Skull and teeth.—The cranial characters given for the genus serve to distinguish the skull (fig. 13) of this species from all other Indiana mammals.

Range.—From Hudson's Bay to southern Indiana and Maryland. It is probable that the jumping mice in this State are intermediate between *hudsonius* and its subspecies *americanus,* but as Mr. Preble records a specimen from Terre Haute as the typical form they may all be considered as belonging to it.

Other Indiana records are: Roselawn, Albion, Lagrange County, Winona Lake, Wabash County, Starke County, Carroll County, Howard County, Richmond, Bicknell, New Harmony.

Habits.—As the above records show, the jumping mouse is to be found in every section of the State, yet it is nowhere abundant. The writer spent the first twenty years of his life on a farm in southeastern Indiana, where he was familiar with most of the animals, yet he never saw a jumping mouse. Later, in collecting more than 300 small mammals in the State, but one jumping mouse has been obtained through his personal efforts. This is in accord with the experience of most other naturalists, although a number of specimens may sometimes be obtained in one season where they had not previously been seen. They are said to be most easily captured in some localities by following the mower as the grass of a low meadow is being cut.

Prof. W. B. Van Gorder writes of its occurrence in Noble County: "In Albion Township in 1895 I took the first jumping

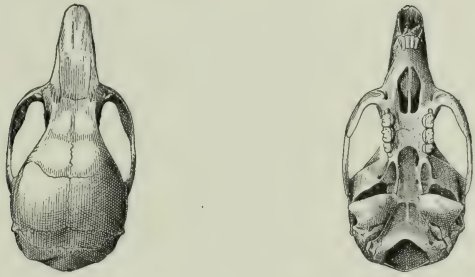


FIG. 13.—Skull of *Zapus hudsonius*: a, dorsal view; b, ventral view. After Preble. N. Am. Fauna No. 15, Bureau of the Biol. Sur., U. S. Dept. of Agri.

mouse I ever saw. In 1907 I saw another, and in 1908, while watching for birds in a willow swamp four of them (jumping mice) came to my notice only a few feet away. They were playing and running about and were very sportive and interesting, when all at once they bounded away like so many little kangaroos."

When frightened these mice make great leaps, apparently going aimlessly and depending on their extraordinary appearance and movements to startle and discomfit their enemies. They can leap six or eight feet and, according to some writers, much farther. Because of this method of locomotion they do not make runways under the grass like most small terrestrial mammals.

The nest is made of grass and is globular in shape, being usually placed in damp meadows above ground, but sometimes it is underground. The young are usually five or six in number and are born in May or June.

These mice are said to have an unusually long period of hibernation, sometimes remaining dormant until May, although they have also been seen running about during mild winters. Mr. Chansler found one in midwinter near Bicknell, hibernating in an underground nest on a side hill near some damp woods. It seemed very stupid and inactive, but ran about some when dug out.

Their food is said to consist principally of the seeds of grass and weeds.

The rarity of the species makes it unimportant from an economic standpoint.

Family ERETHIZONTIDAE.

PORCUPINES.

Rodents with stiff, pointed quills mixed with the fur; feet plantigrade; toes four in front and five behind; molars rooted, four on each side of both the upper and lower jaw.

Porcupines are often confused, in the popular mind, with hedgehogs. The latter, however, belong to the order *Insectivora* and are therefore related to the moles and shrews and are limited to the old world. The porcupines, on the other hand, belong with the squirrels, mice, rabbits and other representatives of the *Glires* or gnawing animals.

The American porcupines belong to a family distinct from those of the old world. They differ from the latter in lacking a thumb, in having complete clavicles and in several other anatomical details.

Genus Erethizon F. Cuvier.

Erethizon F. Cuvier, Mem. mus. d'hist. nat. Paris, Vol. IX, p. 426, 1822.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{0-0}{0-0}$; M, $\frac{4-4}{4-4} = 20$.

Generic characters.—Tail short, thick and not prehensile; form stout and clumsy; quills not equalling the hair in length.

This genus is confined to northern North America, where it lives chiefly in the forests. Two species, each with several subspecies, are recognized. Only one is native to the eastern United States, and it is now extinct in Indiana.

ERETHIZON DORSATUM (Linnaeus).

[*Hystrix*] *dorsata* Linn., Syst. Nat., Ed. 10, Vol. I, p. 57, 1758.
Erethizon dorsatus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 125.

Diagnostic characters.—Those of the family and genus.

Description.—Color dark brown or blackish; quills tipped with yellowish white, two to four inches long and partly concealed by the dark colored hair. The quills are most numerous and longest on the back and are short on the tail, head and limbs, and lacking on the underparts. They usually lie fairly close to the skin and, with the hairs, point backward, but can be erected by muscular contraction.

Measurements.—The following measurements are given by Miller, none being available for Indiana specimens: Total length, 700 mm. (28 in.); tail, 200 mm. (8 in.); hind foot, 90 mm. (3½ in.).

Skull and teeth.—The skull bears a slight superficial resemblance to that of the woodchuck (*Arctomys*) from which it differs in many details, however, and the animals are not closely related. The porcupine skull lacks the post-orbital process possessed by the woodchuck. In the latter animal the rostrum is flat dorsally and squarish in outline. The porcupine skull has a very deep rostrum which is arched upward beyond the level of the braincase and is rounded both dorsally and ventrally. The lower jaw is rounded laterally. The incisors are thick and rounded. The crowns of the molars are characterized by isolated islands of enamel which do not connect with the external ring of enamel.

Range.—Eastern Canada and the northern United States as far south as southern Indiana. Mammalogists who have stated that the range of the porcupine is limited to the Canadian zone are in error, as Wied includes it in his list of mammals from New Harmony in the lower austral zone.

It was once to be found throughout Indiana, but there is probably not a single individual living within the boundaries of the State at the present time. The following is a summary of our knowledge of its occurrence in the State: The Prince of Wied states that it was rare at New Harmony at the time of his visit in 1832-1833. Dr. John T. Plummer wrote in 1844 that it had been killed in the suburbs of Richmond "in the last few years." Mr. Cicero Sims states that they were once numerous in Miami County. Prof. Van Gorder says of it in Noble County: "In 1854 my father killed the only porcupine he had ever seen. The animals

were not abundant, as was learned from various sources. The dog jumped on this one with the evident intention of tearing it to pieces at once, but immediately relinquished his grasp." In the course of several years' trapping along the Kankakee about 1870, Mr. I. N. Lamb saw but one porcupine. Two specimens in the State Museum are said to have been taken in Laporte County not many years ago. Mr. Chansler says that a number of old settlers have spoken of it as being common in Knox and Daviess counties in the period previous to 1836. The last record for that region is 1864, when F. F. Chambers saw one near Chambers' pond in Knox County.

Evermann and Butler give the following records: Lafayette, about 1882; Franklin County, date not stated; Lagrange County, 1860-1870; Huntington County, about 1885; Randolph County, about 1875; Grant County, 1892. The last is the latest authentic record I know for the State, although it probably survived along the Kankakee a few years later.

Habits.—The porcupine is a good example of a species over-specialized for a certain mode of life. In his native woods he was sometimes attacked by lynxes, panthers and perhaps wolves, when these animals were driven to desperation by extreme hunger. But even these fierce creatures often paid the penalty of their greed with their lives. For although the porcupine is an unresisting foe, has armature is dangerous to any captor, and the sharp, barbed quills work their way deeper into the flesh and sometimes penetrate the vital organs. The quills can not be shot out from the animal like arrows, as some people suppose, but they have very sharp, barbed points so that the slightest touch is sufficient to get them into the flesh. Being loosely attached to the animal, they are pulled away, and the barbs prevent their ready extraction and cause them to work deeper into the flesh with every movement of the muscles.

The food of the porcupine is the bark, buds and twigs of trees, and hence there is always an abundant supply in the forests where these animals make their homes. They are active principally at night, and during the day sleep in a hollow log or a hole among the rocks with their spiny backs towards the entrance. They do not hibernate for the entire winter, but remain in their dens during bad weather, apparently from sheer laziness, as an abundance of food is always near.

From the foregoing statements it will be seen that the struggle for existence is almost a negligible factor in the life of the porcu-

pine. Consequently, he has become the slowest, the clumsiest and the most stupid of North American mammals, knowing neither fear nor hurry. Even the task of producing young has been found less necessary than among most species, since the death rate is low. The female gives birth to one or two young each April or May, and the male pays no attention to them. One can not help wondering what the courtship of these sluggish and uncouth brutes is like and whether the young are ever active and frolicsome. But I know of no one who has made observations on this point.

It is in consequence of his over-specialized habits that the porcupine has disappeared from our fauna. Without destructive habits and having no value for food or fur, he would have survived as long as any forest remained had he exhibited any cunning or adaptability. But his uncouth appearance excited man's desire to kill, and the spiny armature, in whose protective powers the creature had absolute reliance, proved wholly inadequate against shotgun and rifle.

Family LEPORIDAE.

RABBITS AND HARES.

This family, which is of world-wide distribution, belongs to a distinct suborder of rodents (*Duplicidentata*) distinguished from the rest by the presence of two pairs of upper incisors, the one pair being directly behind the other. There are also a number of other anatomical peculiarities. The wrist can not be turned as in most rodents and the soles of the feet are thickly covered with fur. The hind legs are much longer than the front ones. The ears are long and the tail is short and carried erect. The names "hare" and "rabbit" are loosely used, the former being generally applied in this country to the larger species, while the smaller ones are everywhere known as "rabbits."

Genus SYLVILAGUS Gray.

Sylvilagus Gray, Ann. and Mag. Nat. Hist., 3d Ser., Vol. 20, p. 221, 1867. Lyon, Smith. Miscel. Coll. (Quart. Issue), Vol. 45, p. 396, 1904.

Dental Formula.—I, $\frac{2-2}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{3-3}{2-2}$; M, $\frac{3-3}{3-3} = 28$.

Generic characters.—The species of this genus were formerly united with large varying hares, jackass rabbits and others in the genus *Lepus*. Lyon and other mammalogists have recently regarded this as a distinct genus because of a number of minor

anatomical characters. The genus can be readily distinguished from those others found in the United States by its smaller size. The species of this genus are the common rabbits or cottontails of central North America. About fifty species and subspecies are known, all of them being found in North America. Apparently only one form occurs in Indiana.

SYLVILAGUS FLORIDANUS MEARNSI (Allen).

COMMON RABBIT; PRAIRIE COTTONTAIL.

Lepus sylvaticus mearnsi Allen, Bull. Amer. Mus. Nat. Hist., Vol. 6, p. 171, 1894.

Lepus sylvaticus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 125.

Lepus floridanus transitionalis McAtee, Proc. Biol. Soc., Washington, Vol. 20, p. 5, 1907.

Lepus floridanus mearnsi Hahn, Proc. U. S. Nat. Mus., Vol. 32, p. 462, 1907.

Diagnostic characters.—Hind foot about four inches; rump paler than back; no dark spot on top of the head between the ears.

Description.—General color of back decidedly brown, with a mixture of black and gray-tipped hairs. Underneath white, with a brown band across the chest. Ears without distinctly blackish margins. The subspecies *transitionalis*, with a more northern range, differs from the above in being slightly smaller, with more black-tipped hairs on the back, the brown being also deeper and richer; the ears are more thickly furred and have blackish margins, and there is a distinct black spot between them. The subspecies *mallurus*, which may be found to occur in the southern part of the State, is also smaller, with shorter, coarser, duller colored hair and the rump nearly as dark as the back.

Measurements.—Ten specimens from Mitchell average: Total length, 435 mm. (17½ in.); tail, 50 mm. (2 in.); hind foot, 95 mm. (3 13/16 in.); ear, 69 mm. (2 13/16 in.).

Skull and teeth.—The skull does not differ greatly from those of the closely related forms. However, the skull and teeth of rabbits differ from those of other rodents in several characters not yet pointed out. The skull is very long and the rostrum is quite deep as compared with the shallow braincase. The sides of the rostrum (maxillary bones) are perforated by many holes, which give it a lattice-like appearance. The ventral surface of the skull is also remarkably open, the palatal region being occupied by the very large incisive foramina. The interorbital foramen is large, so

that in a lateral view of the skull, it is seen to be perforated by a large hole, passing through the eye region from side to side. The molars and premolars are wide in a transverse direction and the upper ones vary narrow antero-posteriorly, with a transverse ridge of enamel in the middle; the last one is small, however, and the first is also of different form. The teeth of the lower molar series each consist of two lobes.*

Range.—The prairie cottontail occupies the upper Mississippi valley from Minnesota to southern Indiana and east to New York and Ontario. Specimens from Mitchell have been identified by Mr. E. W. Nelson, the best authority on American rabbits, as belonging to this subspecies. Those from the northern part of the State are also *mearnsi*, and hence it probably occupies the whole State, although examples from the lower Wabash valley may be found to intergrade with the subspecies *mallurus*. There is not a county, perhaps not a township, in the State in which the cottontails may not still be found.

Habits.—It would be difficult to find two species of mammals that show more contrasts than the rabbits and porcupines. The former are among the most defenseless of our mammals. They can not climb trees nor do they burrow to any extent. When they find a natural cavern among the rocks or occupy a woodchuck's deserted den, they are still liable to attack by bloodthirsty weasels. They have been ruthlessly shot, snared and chased to death by men. The natural enemies include every predatory mammal and rapacious bird.

Yet in spite of their enemies, and in spite of the fact that their intelligence is of a low order, they have frankly acknowledged† their shortcomings, their weaknesses and even their cowardice. As an adaptation to these conditions, they have learned to produce a large number of young each year, so that some may be left to continue the species, although many perish.

Consequently, where the porcupine with few enemies has disappeared, the rabbit still holds his own, although persecuted incessantly. I think it is safe to say that where sinkholes, stony hillsides or thickets and uncultivated land have been left for retreats, the rabbits have not been reduced in numbers since the country was first settled. Although shotguns play havoc with

* This description is based on *S. f. mearnsi* and applies, for the most part, to other cottontail rabbits as well.

† The writer does not mean to imply by this or similar expressions that the animals have reasoned it out. In the race history natural selection has forced upon the species the same results which might have been arrived at by a process of reasoning and perfect control of surroundings.

their numbers, these agencies of destruction have been counterbalanced by the extermination of wolves, coyotes, wildcats and other enemies. But where intensive cultivation removes harboring places, the rabbits are rapidly thinned out, although they do not completely disappear, even in the suburbs of the larger cities.

The cottontails possess another valuable asset in their unspecialized taste. Although they never eat animal food, almost any kind of vegetable matter serves as food. Tender clover, cabbage, apples and other fruits and juicy vegetables are preferred, but when such delicacies are not to be obtained they subsist for weeks on twigs, bark, small shrubs or other coarse vegetation. During the winter they sometimes destroy young orchards or forest trees by gnawing the bark from their bases. However, they prefer the more tender vegetation, such as the wahoo, Christmas fern, young dogwood, sassafras, etc., to the hardwood trees like the oak, and it is only in new plantations that they do much damage to forests.

Occasionally they damage gardens, eating cabbage, beets and other vegetables. I have seen a small plot of peas in an unfenced garden cropped so closely by the rabbits that they never reached the height of an inch. Clover, alfalfa, corn in the shock or the growing ears in the milk are also eaten.

During the summer evenings rabbits will lie at full length on bare patches of compact clay and gnaw at the earth. This may be for the purpose of obtaining salt or other mineral matter, but I have watched them doing it along paths and in fields where there was no reason to believe that there was a considerable quantity of salt in the soil. At Mitchell I used to see them repeatedly in the same place in the open woods near the cabin on University Farm. The tooth marks were plainly visible as long as there was no rain, and in this way it was possible to form an idea of how much they ate. During one period of ten days they gnawed away the earth to a depth of from one-fourth to half an inch, or even more, on an area of approximately a square yard.

One would expect to find that such timid, defenseless creatures would select a secure spot or dig an extensive burrow in which to rear their young. On the contrary, they most often bring them into the world in a nest made of grass, lined with fur from the mother's body and placed on top of the ground, although they sometimes use a ready-made hole in the ground, or a hollow log, or even excavate a little cavity in soft earth under an old stump. The young are usually four in number, but may be from two to seven. Mr. Butler records finding young at Brookville on January

8, 1890. I have found a female with young not ready for birth on Augst 21st in Porter County. The exact number of litters produced in a year is not known, but probably averages three or four, and as the period of gestation is about a month, the potential number is larger.

Economic status.—As the foregoing account shows, rabbits sometimes do considerable damage to gardeners and fruit growers. Methods of trapping and hunting rabbits are too well known to require discussion here. The animals are usually hunted enough to hold them in check so that they do not become a serious pest, but it is not desirable they be given any further legal protection at present.

The Biological Survey of the U. S. Department of Agriculture recommends the application of the lime-and-sulphur wash, used in spraying for the San José scale, to the trunks of young trees needing protection from rabbits. It is made by boiling 15 pounds of sulphur and 20 pounds of unslaked lime in 15 gallons of water for one hour, then adding 30 gallons of water and applying with a brush. A single application is said to protect trees from rabbits for an entire winter. The trees can also be protected by various wrappings or by permanent cylinders made of poultry netting or screen wire. Where orchards are kept free from underbrush, tall grass and weeds, the rabbits are not apt to be numerous. In favor of the animals, it must be remembered that rabbit hunting furnishes good sport and that their flesh makes a very palatable food.

Genus Lepus Linnaeus.

Lepus Linnaeus, Syst. Nat., Ed. 10, I, p. 57, 1758. Lyon, Smith. Miscl. Coll. (Quart. Issue), Vol. 45, p. 389, 1904.

Dental formula.—The same as *Sylvilagus.*

Generic characters.—As restricted by Lyon, this genus includes only the jackass rabbits of America and varying hares of this country, Europe and Asia. As here understood, the water hares of the southern United States are also included. They are distinguished by their large size and by a number of anatomical characters.

Three subgenera and about fifty species and subspecies are included in this genus which is limited to the northern hemisphere. Thirty-five or more species are found in North America, three of them may occur in Indiana.

They may be distinguished by the following key:

Legs and ears very long (ear 4½ in.). Jack rabbit.
L. campestris, appendix.

Legs and ears shorter, the former under 4 in.
Species northern, turning white in winter.
L. americanus phaenotus, appendix.
Species southern, color always brownish; habits aquatic.
L. aquaticus, p. 538.

LEPUS AQUATICUS Bachman.

WATER HARE.

Lepus aquaticus Bachman, Jour. Acad. Nat. Sci. Phila., Vol. 7, p. 319, 1837.
Kennicott, Patent Office Report. 1856.
Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 139, 1894.
Butler, Proc. Ind. Acad. Sci. for 1894, p. 85, 1895.

Diagnostic characters.—Size larger and hair coarser and stiffer than in the cottontail rabbits.

Description.—Back mottled with buff, brownish-red and black, the amount of black being less than in the cottontail; belly and underside of tail white; hind foot relatively short and scantily haired on the underside; ears longer than in the cottontail. The total length is about 21 inches the size therefore being intermediate between the jackrabbit and the cottontail. I have no detailed measurements.

Skull and teeth.—The skull is larger than that of the cottontail and is further distinguished by having the postorbital process solidly joined to the side of the cranium.

Range.—The water hare is limited to the lower Mississippi Valley. Kennicott states that it was not uncommon about Cairo, Ill., in the fifties. Butler has recorded it from Indiana on Mr. Chansler's report. I have no additional records excepting Chansler's statement to me which is as follows: "A very few of these are found here (Knox County). They are larger than the common rabbit and of a brownish color. One of these rabbits was seen by my brother Will, September 17, 1898; also another by Will Staley. It was also seen in 1894; no recent records; seems to be rare; usually found about water or swampy places." I consider these statements reliable enough to give the species a place in the fauna of the State, although no specimens are extant.

Habits.—Kennicott said of the water hare in Illinois that it was generally found in the denser woods and especially the cypress

swamps. Two or more litters of young are produced each year, the nest being placed on hillocks in the swamps or in fallen hollow trees.

In Tennessee, according to Mr. Rhoads, they are never seen on the hills and seldom in the open, but they have held their own in numbers in the cane brakes and deep woods. When pursued they take to the water by preference and can outswim a dog, not infrequently swimming sloughs and streams many yards wide. During the spring freshets they may be seen sitting on floating logs far out in the streams. The water hare is doubtless extinct within our limits at the present time, but it has always been too rare to have been of much importance in the fauna of the State. Because it shuns the vicinity of human beings, this species does not do injury to crops and orchards as the other rabbits sometimes do.

Order FERAE.

THE FLESH-EATERS.

Mammals adapted for eating flesh and for capturing and killing their prey. The canine teeth are well developed and the molars have sharp, cutting crowns; the incisors are generally small and placed in a transverse row between the canines; the tooth row is not broken between the incisors and the molar series, but the teeth are all relatively close together. (See fig. 2.) Feet provided with strong, sharp claws. Brain large and eyes and ears well developed. Size medium or large, the weasels being the smallest American representatives of the order.

This order is indigenous to all parts of the world except Australia. It contains about a dozen families and probably more species than any other order of mammals excepting the *Glires*. About 15 species, belonging to five families, are members of the Indiana fauna, past or present.

Family FELIDAE.

THE CATS.

Feet not plantigrade; toes retractile; hind toes four; front toes five, the inner one not reaching the ground; skull short and rounded; teeth 28 or 30.

This family has a world-wide distribution (excepting Australia) but contains only two or three genera and relatively few species. Two genera are native to North America and both were found in Indiana in the early days of its settlement.

Genus Felis Linnaeus.

Felis Linnaeus, Syst. Nat., ed. 10, I, p. 41.

Dental Formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{3-3}{2-2}$; M, $\frac{1-1}{1-1} = 30$.

Generic characters.—Body slender; tail long; ears rounded, total number of teeth, 30.

This genus includes the domestic cat, together with about a dozen species and subspecies of North American cats, and a number of species in the old world. The panthers, jaguars and ocelots are the typical American representatives of the genus.

FELIS COUGAR Kerr.

COUGAR; AMERICAN PANTHER; PUMA; PAINTER.

Felis couguar Kerr, Animal Kingdom, p. 151, 1792.
Merriam Proc. Wash. Acad. Sci., Vol. 3, p. 582, 1901.

Felis concolor, Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 138.

Diagnostic characters.—Distinguished from other members of the cat tribe in eastern America by its great size, long tail and brownish color.

Description.—Color, yellowish brown above, darker along middle of back; under parts yellowish white; tail blackish at the tip; feet large; ears without tufts of long hair; tail long and rounded, thickly furred and powerful.

Measurements.—I am not aware that there are any measurements in existence for the cougar of the eastern United States nor are there any specimens from which such measurements can be obtained.

Three males and three females killed by President Roosevelt in Colorado are said to have averaged seven feet two inches, the largest male being eight feet in length. The tail is about three feet; the hind foot ten inches.

Range.—Cougars formerly inhabited all of the wooded parts of North America. Several species have been named, but their relationships and distribution are not known. The eastern species, *cougar,* certainly inhabited all of Indiana.

Our knowledge of the occurrence of the species in this State is limited. It probably became extinct about 1850, although it was very rare long before that time.

Most of the county histories are silent as to the occurrence of the animals, even when they speak of bear and deer, and there

seems to be a consensus of belief that the species was never abundant in this State after the beginning of the nineteenth century.

The Prince of Wied says that it had already become extinct at New Harmony in 1832. Mr. Chansler gives the following records for Knox and Daviess counties: One seen in 1825 by Mr. B. Thompson; one in 1828 by N. B. Bruce; two in 1833 by A. Stafford; one near Vincennes in 1837 by Felix Buchie.

Evermann and Butler say that two young were taken east of Brookville in 1838. The historian of Morgan County says that panthers were killed in that county, but gives no dates. In the history of Brown County it is stated that they were seen as late as 1836, and the following incident is given: "Green Graham, on one occasion, went from Jackson's salt works east past Weed Patch Knob. He was riding a mare and was accompanied only by a colt and a cur dog. On nearing the summit of the hill he thought he heard some one call. He answered and the call was repeated several times, growing nearer all the while. At last, just as he reached the top of the Knob, his horse became frightened and he noticed that his dog was also frightened. A minute later the leaves rustled at the right and he saw two huge cat-like forms skulking through the weeds. He knew that the animals were panthers, and put the whip to his mare, going down the hill at a breakneck pace and escaping the animals."

Dr. U. H. Farr, of Paragon, tells of seeing an animal in 1851 when a child of five, which older people told him was a panther, judging from his description. Mr. Cicero Sims tells of capturing "what was called a mountain lion" in a wolf pen in Clinton county. The exact date is not given, but must have been about 1840. His description of the animal leaves no doubt that it was a cougar.

Dr. S. C. Richardson, of Indianapolis, tells of going fishing one night in 1851, when he and three companions were threatened by a panther which they frightened away by rushing toward it with their fish gigs and an ax. It was only seen indistinctly in the moonlight, but its screams were heard as it retreated through the woods. Dr. Richardson's father killed a panther which he discovered crouched in a tree, apparently waiting to spring upon him, sometime previous to 1850. The exact date and place are not given. About the same time one of his steers was attacked in the woods not far from home and horribly lacerated by one of these great cats.

Habits.—According to the most reliable naturalists who have studied the cougar, we must class as "nature fakirs" those who write stories of adventure in which the great cats figure as cour-

ageous beasts that will stalk a man and attack him without provocation. That they will fight desperately when brought to bay, goes without saying. Most carnivorous, and many herbivorous animals will do the same. But courage is not one of the common attributes of the cougar—at least not of the cougar of the present day, although its habits have doubtless been greatly modified where it has come into conflict with guns and hunting dogs. President Roosevelt, who has hunted them extensively and has published one of the best accounts of their habits (Scribner's Magazine, 1901), thinks they are always cowardly and will never attack a man. There is good evidence, however, that some of these animals in the early days, when they had not become acquainted with white men and their weapons, showed considerable courage, and also that they sometimes lay in wait for game and sprang upon it, or even upon a man from vantage points.

Their favorite game, under natural conditions, seems to have been deer. These creatures were stalked until the cougars were within a short distance, when they rushed upon them with a succession of tremendous leaps, springing upon their backs and biting at the neck and throat till the quarry dropped from loss of blood or exhaustion. On the cattle ranges of the west they have been very destructive at times. Although they usually kill calves, colts and sheep, they do not hesitate to bring down an old bull or a full grown horse if other food is scarce. When an animal the size of a sheep is killed, it is often carried away, especially if there are young to be fed, but larger animals are eaten on the spot. Smaller animals are also killed and eaten, and it is said that the cougars will even kill and eat porcupines and skunks.

The den is usually placed in a rocky cavern or under a ledge. The young are born in such a den just at the end of winter. They are from two to four in number, and are naked and blind when born, but soon become active and playful. The young climb trees readily, but the adults seldom do so unless closely pursued.

The species was early exterminated because it came into direct conflict with man. Its great size, strength and ferocity aroused the dread of the early settlers and, rightly or wrongly, they considered their lives endangered by the presence of these beasts. The added effect of their raids on the poultry yard and the stock yard made the conflict the more deadly. As Stone and Cram have pointed out, no species of animal can long survive where its presence is feared by man, and hence the pioneers exerted themselves to their utmost to exterminate the species.

Genus Lynx Kerr.

Lynx Kerr, Animal Kingdom, I, p. 155, 1792.

Dental Formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{2-2}{2-2}$; M, $\frac{1-1}{1-1}=28$.

Generic characters.—Form rather stout and heavy; tail short; teeth 28 instead of 30, as in *Felis;* ears pointed with tufts of long hair.

This genus, which resembles the typical cats (*Felis*) except in the characters given above, is found in the northern part of both hemispheres. The species are commonly known as lynxes, wildcats or "bobcats," the latter name being given on account of the short tail. About 15 species and subspecies, divided into two subgenera, are known from North America. Two formerly existed in this State. They can be distinguished as follows:

Feet very large, twice as long as the tail; ear-tufts large; fur long and loose. *canadensis.*

Feet moderate, not much longer than the tail; ear-tufts smaller; fur short and close. *ruffus.*

LYNX CANADENSIS Kerr.

CANADA LYNX. Sometimes called "WILD CAT."

Lynx canadensis Kerr, Animal Kingdom, I, p. 157, 1792.

Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 138.

Diagnostic characters.—The characters given in the key serve to distinguish the species.

Description.—Color light gray and dark brown, mingled so as to give a somewhat mottled effect; under parts white; tail tipped with black; ear tufts also blackish. The hair is exceedingly fine and so long that it is very soft and yielding, tending to pack into hard lumps when made into furs and robes; the hair of the cheeks is still longer and forms a sort of ruff about the broad rounded head, which makes the animal look much more formidable than it really is. The ear-tufts, which are about two inches in length, add to this appearance. The densely furred, large feet serve as snow shoes for the animal.

Measurements.—The following are the measurements given by Miller: Total length, 1,000 mm. (40 inches); tail, 100 mm. (4 in.); hind foot, 225 mm. (9 in.); breadth of front foot about 80 mm. (3 3/16 in.).

Skull and teeth.—The skull is very broad and powerful as compared with that of the bay lynx.

Range.—Formerly from Indiana, Pennsylvania and Maine to the northern limit of trees in Canada. Now extinct except in the more sparsely settled regions.

In Indiana the records are greatly confused with those of the smaller bay lynx, and, to some extent, with accounts of the cougar. The differences between these three species are well known to hunters and trappers where all are found, but they are all called "catamounts" and "wild cats" by the later settlers, who heard of them now and then, but seldom saw them.

I can not be certain, from the Prince of Wied's account, whether this species was found about New Harmony in 1832-33. He records the lynx as "not rare" and then recognizes the validity of Godman's two species (*canadensis* and *ruffus*), but does not state that both live near New Harmony. Chansler gives a record of one killed near Bicknell in 1832 and mentions several newspaper "records" from Knox County in recent years, but does not place credence in them. Dr. Plummer omits it from his list of Wayne County mammals in 1844. The historian of Steuben County wrote in 1885 that "both lynxes disappeared at least a third of a century ago." The lynx is mentioned in several other county histories, but it is impossible to tell which species is meant. Evermann and Butler give the following records: Franklin County, "formerly found, but never common"; Lagrange County, 1875; Montgomery County, one killed November 22, 1890, near Garfield; Tippecanoe County, one killed in 1885 seven or eight miles west of Chauncy." I think it is extremely probable that these last two records should refer to the bay lynx rather than to the Canada lynx.

Habits.—According to most accounts, this is one of the fiercest animals that roams the northern woods, excelling the cougar in boldness, though lacking its strength. It is the dreaded *Loup Cervier* of the French Canadians and northern Indians.

When game of all sorts is scarce in the northern woods and the lynx becomes fierce with hunger, there are few creatures that he will hesitate to attack. Well authenticated instances are on record of the animals following a man, and since they move rapidly and silently through the tree-tops, there is little reason to doubt that they will sometimes make a fatal attack on a lone hunter. They capture deer by lying in wait and springing on the animal's back, biting and clawing till the deer drops from loss of blood and exhaustion, unless it can get rid of its dread foe by running under the low branches of a tree or jumping into water.

Macfarlane states that the lynxes are subject to periodic in-

crease and decrease in numbers in the Northwest Territories of Canada. The minimum number of skins obtained by the Hudson's Bay Company in any one year was 4,448 in 1863; the maximum was 76,556 in 1868. In 1903 this company obtained more than 9,000 skins. The animals are usually snared by the Indians, although they are also caught in steel traps and hunted with dogs and guns. The flesh is white and tender and much prized by the natives.

The young are born in these northern countries in June or July and have the eyes partly open, but are helpless and are suckled about two months by the mother. There are from two to five young in a litter.

LYNX RUFFUS (Gueldenstaedt).

BAY LYNX; WILD CAT; CATAMOUNT; BOB CAT.

Felis ruffus Gueld., Novi Comme. Acad. Acient. Imp. Petropolitanae, Vol. 20, p. 484, 1776.

Lynx rufus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 138.

Diagnostic characters.—General color yellowish brown instead of gray; proportions as given in the key.

Description.—Color yellowish brown, with dark brown or blackish spots and streaks and a blackish line down the middle of the back; belly white with dark spots; throat more or less brownish. Feet small; tail moderate; ear tufts about one inch; fur short and dense, much as in the house cat.

Measurements.—From Miller: Total length, 900 mm. (36 in.); tail, 170 mm. (6¾ in.); hind foot, 180 mm. (7⅛ in.); breadth of front foot about 50 mm. (2 in.).

Skull and teeth.—The skull is narrower than that of the Canada lynx and of course smaller.

Range.—From Georgia to Maine and west to the Rocky Mountains. Closely related species are found to the south, north and west, but all have been greatly reduced in numbers and exterminated in much of their former range.

Indiana records are as follows, the dates being the latest authentic records I have been able to find for different parts of the State, but not necessarily the date of extermination; New Harmony, not rare in 1833 (Wied); Wheatland, January 10, 1900; adult and two young killed near Montour's Pond in Knox County in 1894 (Chansler). In Franklin County Dr. Haymond reports them as occasionally seen, but rare in 1869, and Butler remarks

that this was about the end of their existence in that county. Dr. Plummer says that they were seldom seen near Richmond after 1823. Edwin Dinwiddie, in T. H. Ball's history of Lake County, says that two were seen about Pleasant Grove in that county from 1855 to 1867, but that there are no authentic records since the latter date.

Mrs. Annie Anderson, of Oxford, relates the following story concerning the occurrence of lynxes in Benton County: "In August, 1870, when I was about ten years old, my brother and I were gathering berries on the banks of Pine Creek, about four miles south of Oxford, when I spied in some hazel brush what I thought to be a maltese cat. I called to the kitty and started to catch it, when my brother stopped me, saying that he did not like the looks of its eyes. It was standing still, staring at us, evidently as much surprised as we were. In the following autumn some hunters killed a lynx in the same place, and it proved to my maltese kitty or one like it. I have not heard of any since until about three years ago (1905) some boys killed a bobcat about a mile from the same place."

Mr. Theo. F. Upson states that he killed a "bobcat" near Lima, Lagrange County, in the fall of 1857, and knows of none in that vicinity since. Robert S. White, Jr., killed a "catamount" on Pigeon Creek, Warrick County, in the winter of 1906. This is the latest record that I have been able to obtain. Newspapers frequently print more or less sensational stories about wildcats in various parts of the State, and no doubt some of them are true, but I have not been able to verify any of them. As the accounts usually do not state positively whether the animal in question is a wildcat, a wolf, or an escaped circus lion, I have not taken these stories into account. Nevertheless it is very probable that a few wildcats remain at the present time in the less accessible swamps and woods in various parts of the State.

Habits.—This lynx is merely a smaller edition of the preceding species and, so far as I am aware, does not greatly differ from it in habits. The smaller size may render it unable to kill some of the animals on which the larger species preys. Both hunt by stealth and rely on chance to find their quarry, since they can not trail it as do the wolves.

They have learned to hunt even more quietly since the country has become thickly settled, and thus have escaped extermination. They have a shrill, piercing cry, but this is seldom heard, even at night. Their size and strength is not sufficient to make them dan-

gerous to human life, although they are much feared. They often kill poultry, and also lambs and pigs, but those animals that have habitually molested farmers have been hunted down and only the ones that conduct their still hunt in the swamps and forest have survived. Because they have learned retiring habits, they escape observation and have lived for years in places where their presence was not suspected. When hunger drives them from their retreats to seek food about the farms, people are astonished and unduly alarmed by their presence.

Family CANIDAE.

DOGS, WOLVES, COYOTES AND FOXES.

The members of this family resemble the cats (*Felidae*) in being carnivores with digitigrade feet. The toes are four on the hind feet and five on the front ones (except in the Cape hunting dog of South Africa, which has only four toes in front). The claws can not be retracted into a sheath and usually are comparatively blunt and straight. The skull (figs. 2 and 14), especially the jaws and rostrum, are long and the teeth number 42 in all the American species.

Like the *Felidae*, this family contains only a few genera, but the species are probably more numerous. The family has a world wide distribution, one species being found in Australia, where it was doubtless introduced. Three genera are found in North America, all being represented in Indiana.

Genus Urocyon Baird.

Urocyon Baird, Mamm. N. Amer., p. 121, 1857.

Dental Formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{4-4}{4-4}$; M, $\frac{2-2}{3-3} = 42$.

Generic characters.—Front teeth with straight cutting edges (no lobes); skull with two crests or ridges along the temporal region (fig. 14); instead of the single median crest usual among the carnivora; tail with a mane of stiff hairs.

The gray foxes of this genus are limited to the western hemisphere, where they have a range extending from South America into southern Canada. Ten or twelve species and subspecies are known, only one of which occurs in Indiana.

UROCYON CINEREOARGENTATUS (Schreber).

GRAY FOX.

Urocyon cinereoargentatus (Schreber), Säugethiere, Vol. 3, pl. 92, 1775.

Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 52, 1894.

Hahn, Proc. U. S. Nat. Mus., Vol. 35, p. 575, 1908.

Diagnostic characters.—The generic characters serve to distinguish the gray fox from other Indiana species.

Description.—General color of the back, gray; the hairs being banded with black and white or gray; the black predominates in the middle of the back, forming a median dorsal stripe; tips of the ears and the middle line and tip of the tail also black. Sides of the neck, most of the ears, a band across the chest, the sides of the belly, the hinder and part of inner surfaces of the fore legs, the inner surface of the hind legs and the under part of the tail are all brownish in color, the exact shade varying somewhat in different parts of the body as well as different individuals. Throat and belly whitish; a spot between the eye and the tip of the nose blackish; lips mostly white; form somewhat stouter than that of the red fox.

A subspecies, *Urocyon cinereoargentatus ocythous,* has been described by Bangs from southwestern Wisconsin near the Mississippi River. The Indiana specimens are, perhaps, somewhat intermediate between this and the typical form. The skin of the only Indiana specimen I have taken was lost and, unfortunately the detailed description and measurements of the fresh specimen are also lost. However, I carefully compared it at the time with Baird's description of a specimen from Washington, D. C., and noted no important differences except that the Indiana specimen was tinged with cinnamon over the white of the throat and most of the belly.

Measurements.—Miller gives the following measurements: Total length, 900 mm. (36 in.); tail, 260 mm. (10¼ in.); hind foot, 125 mm. (5 in.).

Skull and teeth.—The striking features of the skulls of the gray fox are the temporal crests which extend along the edges of the dorsal side of the skull (figs. 2 and 14), meeting in the occipital region, diverging anteriorly, and joining with the postorbital process. The top of the skull between these crests is smooth, while the sides below them are roughened for the insertion of muscles. The rostrum is shorter and broader and the interorbital region is also

broader than in the red fox. The nasal bones extend farther posteriorly, than the maxillaries, while in the red fox they do not extend as far. The lower jaw is remarkable in having a notch on the lower edge just in front of the angular process, which appears to be an accessory process for the attachment of muscles of mastication. The teeth are smaller in the gray fox than in the other.

Range.—Gray foxes are found throughout most of the United

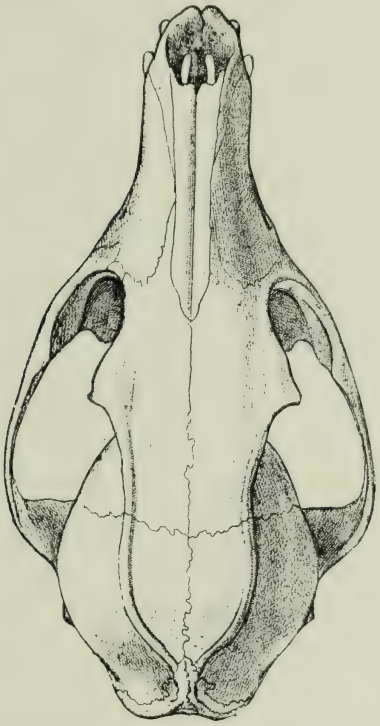


FIG. 14.—Skull of *Urocyon cinereo-argentatus*. After Baird.

States. The typical form extends from Florida to New York and from the Atlantic west to Indiana.

The gray fox was formerly common in nearly all parts of the State, but it is fast disappearing. Wied states that it was abundant at New Harmony in 1832. Dr. Plummer says of it in 1844 that it is "still found in the more wooded districts." Dr. Haymond, in 1869, says that it is probably as abundant as ever near Brookville. Butler says in 1893 that it is still found in Franklin County, but it is rare. Mr. Chansler knows of no positive records for Knox County since about 1895, although he states that what

was called a silver fox, but probably was this species, was taken near Emison, Knox County, in 1905. Prof. Van Gorder states that it formerly occurred in Noble County, but is now rare or extinct. Mr. I. W. Burton, of Roselawn, and others familiar with the Kankakee region, have told me that the gray fox never inhabited the swamps, but that it has been known to occur in the higher woods in that part of the State. At present I know of but two localities in which these foxes still live, although there are doubtless others. These places are the rough, partially wooded hills along Willow Creek in Ohio County and the rough land along the East Fork of White River near Mitchell.

Habits.—The gray fox is more retiring and shy in disposition than its red cousin. It is a creature of the forest and is seldom found where the timber has all been cut away.

Exactly why these creatures should be driven out where their red brethren still abound, is a question I can not fully answer. They seem to have less cunning and to be quite unable to hatch up plans for deceiving men and dogs in the way the red foxes do. However, there seems to be something more, some innate hatred of the cultivated field and open range, which drives them away before advancing civilization. In some ways they seem to have an advantage over the red species, for they are more protectively colored and their pelts are of less value. Stone and Cram say they are equally swift, but there seems to be a general opinion among Indiana hunters that they are not so swift and their more stocky build also indicates this.

According to Stone and Cram, the gray foxes seldom live in burrows, but make their dens in hollow logs and old tree trunks. This may have been the case with the gray fox of former days, but it is not true in Indiana today. At the present time the dens do not differ from those of the red fox, but they are never placed out in the open fields as are those of the latter species. At Mitchell I found a den not more than 150 yards from an inhabited house, but it was in dense woods on top of a little knoll where there was little likelihood of its being discovered. Another den, likewise near a house, was in the bottom of a sinkhole which seemed to have connection with quite an extensive cavern. Some hunters ran a fox into this latter refuge one night and attempted to dig it out, but gave up the task when they discovered, after more than an hour's work, that the den was in a rock lined cavern, too small for a man to enter, but probably of considerable length.

At the same place I chanced to glance out of the window one quiet Sunday morning when the hounds were baying in the distance, just in time to see a gray fox trotting up a woodland path. It stopped about 30 yards away and listened, then made a detour to avoid the house, stopping several more times near by, apparently oblivious to my presence, although in the meantime I had quietly left the house and was in full view of the animal. It seemed to have used that path before, for it made for a place where there was a break in the close barbed wire fence, then crossed the road, sprang upon the rail fence, ran along its top for a rod, stopping to listen again, and then, as the hounds were coming nearer, it went on across a meadow at an easy trot.

Later in the year, when the spring rains had swollen the creek, I set a steel trap at the end of a log which spanned the current, placing some brush so that any animal crossing the bridge would have to leave it at the spot where the trap was placed. Next morning a large adult male gray fox had been caught in the trap. He first tried to spring away at my approach, but then showed fight. At about the same time, the middle of March, some boys in the neighborhood dug five cubs from a den in the woods, and kept them as pets for some time.

The food of the gray fox consists of any sort of small mammals or birds the animals can capture, supplemented by insects, frogs, fishes, snakes, carrion and sometimes fruits and nuts. The animals sometimes rob poultry yards, but their retiring habits and rarity make them lesser offenders in this respect than the red foxes. Their bark resembles that of the red fox, but has less volume.

Genus Vulpes Frisch.

Vulpes Frisch, Das Natur-system vierfüss. Thiere, Tabl. Gen., 1775.

Dental Formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{4-4}{4-4}$; M, $\frac{2-2}{3-3} = 42$.

Generic characters.—Size medium; upper incisors lobed; pupil of eye elliptical; fur soft and full all over, the tail being covered with the same kind of hair on all sides; skull with slender, elongated rostrum.

The genus *Vulpes* is found in the northern hemisphere, both in the old world and the new. More than 20 species and subspecies are found in North America, only one of them occurring in Indiana.

VULPES FULVUS (Desmarest).

RED FOX.

Canis fulvus Desmarest, Mammalogie, Vol. I, p. 203, 1820.

Vulpes fulvus DeKay, Zool. N. Y. State, Mammalia, p. 44, 1842. Hahn, Proc. U. S. Nat. Mus., Vol. 32, p. 462, 1907.

Vulpes vulpes Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 138, 1894.

Diagnostic characters.—Color of back fulvous or rusty yellow. This, with the generic characters, should serve to distinguish the species.

Description.—Back fulvous or rusty yellow, darkest on loins and shoulders and with grayish bands on the hairs of the rump and flanks which give a grizzled appear to those regions. Most of the under parts only slightly paler than the back but there is a narrow line of whitish along the middle of the belly which broadens out and extends down the inner side of the legs; lower part of face and chin and throat also whitish. Tip of nose, end of tail, outer side of legs and all of the feet blackish, the extreme tip of the tail being whitish, however. The ears are whitish on the inner side and edges, but black on the convex surface, except at the base.

The cross fox, silver fox and black fox are color varieties of this species. In the cross fox there is a broad, indistinct bank of blackish across the shoulders and another longitudinal band between them. The silver fox has blackish fur tipped with silvery gray, and the black fox is a melanistic form with the color chiefly black.

The ears are very large, the legs are long and slender and the tail very large, soft and bushy. The fur consists of two kinds of hairs, the soft under fur being concealed by long hairs. The latter are evenly distributed on the tail and do not there form a mane as they do in the gray fox.

Measurements.—From Miller I take the following: Total length, 1,000 mm. (40 in.); tail, 360 mm. (14⅜ in.); hind foot, 150 mm. (6 in.).

Skull and teeth.—The skull can be distinguished from all other north America *Canidae* (except closely related forms) by the long, slender rostrum. In the region between the eyes it is somewhat flattened dorsally, but is not nearly as broad, nor is the braincase as flat as in the gray fox. On the other hand, the teeth are broader and heavier, the canines being also much longer.

Range.—From southern Canada to Georgia and from the Atlantic to the Rocky Mountains. Related forms are found to the

north and west. The range of this species, therefore, includes all of Indiana.

I think there can be no doubt that this species has been introduced into Indiana since the coming of the white man. It has long been a mooted question whether the red fox of North America is not identical with the species of Europe. Such able mammalogists as Baird and Merriam have decided independently that the species are distinct. However, the historical evidence is strongly in favor of the introduction of the species and this evidence has not been controverted. But it does not prove that there are no tangible distinctions between the foxes of the two continents at the present time, for more than two centuries have elapsed since the supposed introduction of the animals, and strongly marked domestic breeds of animals have been produced in a much shorter time; and evidence has been brought forward in recent years which seems to indicate that environment has a marked and direct effect on species. This being true, the time is ample to produce new species as is shown by the rapidity with which new varieties of domestic animals are evolved.

The following is a brief summary of evidence of introduction into Pennsylvania as given by Rhoads (Mamm. Penna. and N. J., pp. 145-147). Kalm stated in 1770 that the red foxes were very scarce in Pennsylvania and New Jersey, and that the Indians stated that they were never in the country until the coming of white men. The first red fox ever seen in Perry County, Pennsylvania, was killed in 1787. The people did not, at first, know what it was, but finally an old Jerseyman stated that it was an English fox and that one of the first English governors of New York had imported the foxes from England and turned them loose on Long Island for the purpose of sport. The cave deposits from Carlisle and other bone caves in Pennsylvania contain many remains of the gray fox, but none of the red. I am unable to understand Mr. Rhoads' statement that the red fox must have been in the region to the north of the Great Lakes in pre-Columbian times, and do not know whether he thinks that some of the foxes were imported while others are the descendants of a native American race. This seems to me an impossible supposition.

The evidence of the introduction of the species into Indiana is as follows: Prince Wied (Säugethiere Nord Amerika) mentions its occurrence in Pennsylvania and New York in 1832, but does not mention it at New Harmony, although he speaks of specimens of the gray fox. In his "Reise" he speaks of both species at New

Harmony, but this is a general account of the itinerary published previously to the publication of his little book on mammals; the latter was probably based more carefully on notes and specimens and would naturally be the more accurate of the two. Dr. Haymond, in 1869, distinctly stated that it had not been observed until the last ten or fifteen years. Dr. Plummer, in a list of 43 species of mammals found about Richmond in 1844, includes the gray fox, but omits all mention of the red species. Mr. Chansler states that he does not know of any records from Knox County previous to 1870, when one was killed close to the junction of White River and Indian Creek.

At the present time these foxes do not seem to be diminishing in numbers. Most of the evidence I have on this point was collected during the summer of 1905. At that time they had become very bold and numerous in the fertile, thickly settled valley of the Ohio River between Rising Sun and Aurora. In a distant part of the State, at Mountayr, Newton County, they were also a pest. One farmer there told me that he had lost not less than 150 chickens from their depredations that year. He poisoned the bodies of some of the chickens they buried, and found carcasses of four foxes which the poison killed. He did not know how many hid away where their dead bodies were not found. In 1908 they were very abundant and bold near Bascom, Ohio County.

Habits.—So many of the traits of the fox have passed into proverb and story that it does not seem possible to add much to our knowledge of its habits, except through detailed studies of its psychology. Certainly, much that has been written concerning the cunning and almost human sagacity of the red fox, or "Reynard," should be classed with the fables rather than the natural histories. But fables aside, foxes are undoubtedly among the most cunning, the most adaptable of our mammals and an accurate account of the life history of one of the creatures, together with experiments to determine its teachability, would be a valuable contribution to animal psychology. The fox is at his best when leading the hounds a merry chase. His tricks for throwing them off the scent are innumerable and their chief aim and result is to make the progress of the hounds slower rather than to make them lose the trail entirely. One of the simplest of his devices is to double on his own track, going back to some convenient point on the trail, then leaping far to the side, often over a bank or into a thicket. The baffled hounds have to circle far and wide before they can pick up the lost scent. The old-fashioned rail fence afforded other opportunities

and the fox would run along the top rail for some distance, then spring aside into the bushes. In places where there is much ice in winter it is said that the light-stepping fox delights to cross on thin ice, leaving a good trail on either bank, and the heavier hounds, coming down with a rush, often break through.

Stone and Cram say that the fox delights to trail the hunter, and give an instance of two hunters hurrying to head off a fox where they thought it would cross a stream, while all the time the fox was following in their footsteps. These authors, who base their observations chiefly on New England foxes, say: "It does not worry him in the least to have the dogs close on his heels; he knows that they are afraid to touch him and that he can easily leave them miles behind whenever he cares to. I have more than once seen a fox turn and drive the hounds back when they got too close."

What miserable, cowardly curs they must use for fox hunting in New England! I have heard it said that a dog will not attack a female fox during the mating season. But when the lust of the chase is strong and the pack, led by some giant, bass-noted black and tan, with the tenor of the brindle and the shrill soprano of the "yelper" (mongrels all, but trained to the chase) swelling the chorus, bursts over the hilltop and catches the warm, body scent as the fox speeds down the lower slope, there is neither fear nor mercy in the hearts of the hounds. The race then becomes deadly earnest to the fox, for his life hangs in the balance. Little time is there then for strategy and none at all for delay. Speed, and speed only can save the fox, although he may choose the roughest paths and lead the chase uphill, where his wind lasts better than that of the hounds, and so gain a breathing space in which to execute other maneuvers for throwing the dogs off the scent.

I have known of a number of instances in southern Indiana where dogs have run down foxes and killed them without hesitation. When they fail to kill it is invariably because they can not catch the sly brutes.

It can not be questioned that foxes are among our most destructive animals. At the same time, there is a dash and wit about their thievery that makes one feel somewhat lenient toward them. A fox would about as soon take a chicken from a farmyard when there are two or three men in sight as at any other time, and he seldom fails to make a successful get-away with his booty. The chicken yard suffers most from their depredations, but other poultry are also relished, and rarely a young pig or lamb is the victim.

The stealing is usually done in daylight, although geese and ducks or other poultry roosting on the ground are not safe at night. The fowls are usually seized by the neck, given one quick bite to prevent any squawking, and thrown over the fox's shoulders so that he can carry them without greatly interfering with his speed. Stone and Cram state that thirty pullets have been taken by one fox in a single night. The foxes do some good in return by destroying great numbers of field mice, ground squirrels and woodchucks. But it is doubtful whether they compensate for the loss they cause to poultry raisers.

The foregoing account shows that hunting with dogs is not an effective method of destroying the animals. Poisoning is often more effective. Foxes have a habit of burying surplus poultry when they get more than they can eat. Strychnine introduced into the carcasses so buried will sometimes destroy the animals, but care must be taken to touch the carcass only with gloved hands, for an adult fox is wary of the man scent.

For the same reason it is not easy to trap them, as they have learned to be very cautious about approaching a baited trap. Perhaps the most effective way of trapping is to place the trap at the end of a log which bridges a stream, placing brush so that the animal is compelled to leave the log where the trap is hidden. Foxes are exceeding chary about wetting their feet and invariably seek for some bridge instead of wading or swimming a stream.

However, the fox-drive is one of the most effective ways of ridding a neighborhood of the pests. In these drives a hollow square, several miles across, is formed by a large number of men and boys. At a given time all of the lines move toward a central point previously agreed upon. The shouting of the men as they advance through the woods and fields drives the foxes from their hiding places, and as the lines draw near together the men are too near each other for them to escape. Even in such circumstances the fox's cunning does not fail him, and the writer knows at least one instance in which a fox, finding the line too strong to break through, hid among some briars and weeds along a fencerow until the men were past. By accident, he was discovered, but it was too late to turn him into the square and he escaped.

It must be admitted that the above method is not a very sportsmanlike way of hunting, but it is justifiable on the ground that the animals are a pest where they are numerous. As they kill large numbers of quail and songbirds, I doubt that their beneficial qualities ever equal the harm they do, unless we take into consideration

the sport that fox-hunting furnishes. In recent years, the English custom of hunting on horseback has grown up to some extent, but it is in a very much modified form, the horses being generally mere farm or driving horses and their riders a few enthusiastic farmers instead of a company of fashionably dressed men and women.

Genus Canis Linnaeus.

Canis Linnaeus, Syst. Nat., ed. 10, p. 38, 1758.

Dental Formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{4-4}{4-4}$; M, $\frac{2-2}{3-3}=42$.

Generic characters.—Upper incisors with distinctly lobed cutting edges; pupil of the eye circular instead of elliptical as in the foxes; size usually rather large in the wild American species.

The genus *Canis* includes our familiar domesticated dogs and hence has a world wide distribution. The wild species are also native to most parts of the world, nearly 20 species being found in North America. Two species occur in Indiana. They may be distinguished as follows:

Color gray, darkest on back and shoulders; hind foot about 9 inches; tail 15 inches or more *occidentalis.*

Color more yellowish; hind foot less than 8 inches; tail under 8 inches. *latrans.*

CANIS OCCIDENTALIS (Richardson).

GRAY WOLF; TIMBER WOLF.

Canis lupus occidentalis Richardson, Faun. Bor. Amer., I, p. 60, 1829.

Canis lupus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 135, 1894.

Canis occidentalis Bangs, Amer. Nat., Vol. 32, p. 505, July, 1898.

Hahn, Proc. U. S. Nat. Mus., Vol. 32, p. 462, 1907; Vol. 35, p. 576, 1908.

Canis nubilis McAtee, Proc. Biol. Soc. of Wash., Vol. 20, p. 6, 1907.

Diagnostic characters.—The gray fur with the darker shoulder patches, and large size, distinguish this species.

Description.—Back usually grizzled gray, darkest along middle line and over the shoulders and hips; sometimes more yellowish; belly dirty white. The color varies greatly; hair long and rather coarse; body large and powerfully built.

Measurements.—I have no measurements of Indiana specimens.

Miller gives the following for the species: Total length, 1,465 mm. (58 in.); tail, 405 mm. (16 in.); hind foot, 225 mm. (9 in.).

Skull and teeth.—Skull very large and teeth strong and powerful; a median crest of large size is found along the mid-dorsal line in old individuals, especially males, but is lacking in the young. The skull of an old male in the New Harmony collection measures 8.5 inches in greatest length; maxillary tooth row 3⅝ inches.

Range.—The range of this species is unknown but it probably extended in former times from the gulf states to the Arctic regions and from the Atlantic Ocean to the Rocky Mountains. It is also somewhat uncertain as to whether the specific name, *occidentalis,* is the correct one for the wolf of this region. A large number of specific names have been bestowed on American wolves and their status and relationships have not been worked out.

There is no doubt that timber wolves were abundant throughout Indiana in early days, although the records are somewhat confused with those of the prairie wolves. Wied says the former were not uncommon in the great woods about New Harmony in 1832 and 1833, and their howling was often heard on cold nights. Dr. Plummer says that none had been seen near Richmond for 15 years previous to 1844.

The great abundance of wolves in the early days is attested by many accounts. In Jefferson County, Prof. Glenn Culbertson states that a den was found as late as 1830. A Mr. Hamer, of Mitchell has told me that he has often heard his grandfather speak of the pack of wolves which followed him into the valley leading from Hamer Cave when he took up a homestead there about 1835. He did not reach the place till nightfall and had a small herd of cattle and hogs which doubtless attracted the beasts.

This was probably about the time they began to decrease in numbers and after 1840 they were not generally abundant in the southern part of the state. Those that have been found in Brown, Lawrence and Knox counties in recent years are doubtless descendants of a small colony that has survived in that region and there may have been others in a few of the swamps and rough regions of the state. In the northern part they were numerous until about 1840. The historian of Wabash County tells of seven being killed in one afternoon in 1849, but it is not certain whether these were timber wolves or coyotes.

Mr. Upson states that wolves disappeared from Lagrange County about 1840. Mr. Sims tells of the capture of 8 timber

wolves, one of them black, in Clinton County, but does not give the date.

Mrs. Annie Anderson has contributed the following amusing account from Oxford: "It was about 1874 that Benton County had its lion scare. Full grown hogs and sheep and even yearling colts and calves were hurt so that they died or had to be shot. Some of the farmers kept watch, and finally saw the animal but were too much frightened to shoot, and seeing it in the half light, declared it to be like a female lion full grown. As time went on more stock was killed and the people in the central and north part of Benton County were afraid to send their children to school.

"Finally they organized a 'lion' hunt and hunters came from all parts of the country. The excitement had become so great that an American across the ocean read in the European papers that 'Benton County, Indiana, U. S. A., is infested by lions.'

"When the day came the hunters formed in a circle, and coming together near the center of the county, caught and killed the 'lioness,' which proved to be a large *timber wolf*, larger and fiercer than any of his prairie brothers, and none of his kind have since been seen."

Chansler states that Mr. James Sprinkle helped to kill a wolf in Gibson County in 1890. He also says that Mr. Nute Chambers killed a white wolf with just a little tinge of blue on the under parts on the McCray marsh north of Bicknell, Knox County, in 1880. McAtee records it from Brown County in 1902. In March, 1907, an animal was killed at Springville, Lawrence County, which was pronounced a timber wolf by those who saw it. Mr. C. H. Cobb, on whose farm it was killed, has furnished me with a somewhat crude description of the animal, and from this I judge that the identification was correct.

December 19, 1908, a wolf was killed near Monroe City in Knox County. Prof. Max M. Ellis of Vincennes University saw the animal and writes me that it was not a coyote but a timber wolf, measuring about three and one-half feet from tip of nose to root of tail. This record is more positive and reliable than any others of recent date and removes all doubt concerning the survival of species up to the present time.

Papers in Indianapolis and other towns in the State, as well as in Chicago and other cities, contain frequent accounts of wolf hunts in northern Indiana, but all of these that I have been able to run down apparently refer to the prairie rather than the timber

wolf. However, Hon. L. Darrow, of Laporte, who has hunted the animals, regards some from northern Indiana as gray wolves, or crosses between the gray wolf and coyote. One that he killed weighed 63 pounds, which would be a very heavy, though not impossible weight for a coyote.

Habits.—The methods of the wolves in seeking their prey afford a marked contrast to the habits of the lynxes and other members of the cat tribe. Instead of the ambush and still hunt used by the latter animals, the wolves resort almost wholly to the open chase, not attempting to slip up on their quarry, but relying on fleetness of foot and soundness of wind. All the while they make the night resound with their howling, which serves not only to strike terror into the hearts of the weaker creatures of the forest and plain, but also to call their kind to aid in bringing down the quarry. They are social animals more truly than the bison or any other mammals, for their success in securing food depends largely on their united efforts. Their social habits are not prompted by love, and if we may believe the tales of many pioneers and hunters, they turn upon the weak and wounded of their own kind in times of famine and devour them. It seems, therefore, that this habit of hunting in packs has been developed by natural selection. The wolves that joined forces fared better than those that did not, and hence the habit of joining forces for the hunt has been perpetuated.

The early settlers lived in considerable fear of wolves. It is possible that the animals would attack a lone and unarmed man, when driven by hunger, in those days before they learned to know and dread the white man. Certainly a child alone in the woods on a winter night would not be safe. But the wolf is a cowardly, skulking animal, and where it survives at the present time there is little danger that even the largest and hungriest pack will attack an active man. They are, moreover, cunning and teachable animals, and have learned that man is their superior, and hence leave him alone. Mr. Ernest T. Seton's stories of wolves that have learned to profit by all sorts of experiences, and have taught others of their kind to avoid traps, poisons and man, are to be regarded as idealized rather than scientifically accurate accounts, but they are founded on many incontrovertible facts.

The family life, like the social life, of these animals, is more highly developed than is usual among mammals. The animals mate in late winter, the young being born two or three months later. The pair remain together during the summer, the male doing most of the hunting while the whelps are small. Later the parents

teach the young to hunt and during the summer and fall they join with other families to form the pack. It is stated by some observers that the male and female remain mated for life, but this has not been certainly established.

Deer constituted a large portion of the food of wolves in the primeval forests. They were probably fleeter than the wolves on solid ground, but were easily captured where the snow was deep and crusted slightly so that it bore the weight of the wolves but allowed the sharp hoofs of the deer to break through. At other times the habit of hunting in packs made it possible for some of the wolves to turn the deer from a straight course while others could cut across the angles made by the quarry, and so head it off. Rabbits, ground-squirrels, mice and birds also furnished food for the wolves and nothing in the way of flesh or carrion is refused in time of hunger.

CANIS LATRANS Say.

COYOTE; PRAIRIE WOLF.

Canis latrans Say, Long's Exped. to the Rocky Mts., I, p. 168, 1823.

Hahn, Proc. U. S. Nat. Mus., Vol. 32, p. 462, 1907

Diagnostic characters.—Smaller than the timber wolf, with fur yellowish gray, grizzled with black.

Description.—Long fur of back fulvous, with black tips; under fur gray; head more brownish; back of ears reddish brown; legs tawny; tail the same color as the back except on the under part at the base, where the black tips of the hairs are not found; soles of feet black. The above description is taken from two specimens killed in Jasper County, three miles north of McCoysburg, by C. W. Bussel on May 16, 1906, and sent by him to the National Museum at Washington.

Measurements.—Measurements taken from the above mentioned specimens in the flesh are as follows: Adult male, total length, 1,095 mm. (43 inches); tail, 165 mm. (6½ in.); hind foot, 195 mm. (7¾ in.); ear from crown, 105 mm. (4⅛ in.); height at shoulder, 560. mm. (22 in.). Adult female, total length, 1,040 mm. (41 in.); tail, 130 mm. (5⅛ in.); hind foot, 185 mm. (7½ in.); ear, 110 mm. (4⅜ in.); height at shoulder, 500 mm. (20 in.).

Skull and teeth.—The skull resembles that of the timber wolf in its more prominent features but is smaller.

Range.—Coyotes are distributed from Indiana to the Pacific Ocean and from Central America to within 300 miles of the Arctic

Circle. They are divisible into a number of species, the ranges of the different ones not being very well known. The species *latrans* apparently occupies all of the country from Indiana west to the Missouri River and perhaps to the Black Hills region, and north to Athabasca.

The history of its occurrence in Indiana is peculiar, and it does not seem to have been recorded from the State in any publication likely to fall into the hands of a naturalist, except Butler's notes on Indiana mammals, published in 1894, and the author's List of the Mammals of the Kankakee Valley, published in 1907, although the settlers in the northern part of the state recognized it in the early days.

As far as I can ascertain, it did not occur in the southeastern part of the state; it is an inhabitant of the prairie rather than of the forest. Wied speaks of the abundance of timber wolves at New Harmony and then says a different species occurs on the prairies to the west. From this I infer that he did not see it in Indiana. Neither Plummer nor Haymond mention it in their lists and Evermann and Butler also omit it. Mr. Chansler mentions it as being moderately common about the prairies near Vincennes in early times. He says: "one was observed following a man with some beef just north of Vincennes in 1858. One was observed by Mr. M. S. Kelshaw in 1870."

In the northern part of the State the coyotes were once numerous, then became almost extinct, and in recent years have again increased greatly in numbers. Edwin Dinwiddie, in Rev. Ball's history of Lake County in 1884, mentions them in the past tense. The historian of Jasper County also mentions both timber wolves and coyotes in the past tense in 1883, but gives no details of their occurrence except the mention of a "drive" in the early 40's in which six or eight wolves were killed. Prof. Van Gorder says they disappeared from Noble County in the early 40's. Hon. L. Darrow, writing in 1904, said: "They were unknown three or four years ago, at least to the oldest inhabitants of this [Laporte] County." Mr. Upson says they became extinct in Lagrange County about 1840.

In recent years there have been many reports of wolves killed at various places in northwestern Indiana. As stated in the account of the timber wolf, it is not possible to tell definitely in most cases whether coyotes or timber wolves were the ones killed, but all reports that I have been able to trace up seem to refer to coyotes. The following records are those which I have considered reliable, some of them having been verified and a few taken from news-

papers: Otterbein, Benton County, four killed in the winter of 1905-6 by H. A. Sutton, of Montmorenci (Sportsman's Review, Feb. 3, 1906). Calumet, Lake County (several apparently reliable accounts in Chicago papers). Toleston, Lake County, Mr. A. Rump wrote to the Smithsonian Institution in 1905, offering to get specimens of wolves of two kinds from Toleston. Roselawn, Newton County, one killed by I. W. Burton early in 1905. A pair were chasing Mr. Burton's dogs early one morning. The dogs turned on them when near the house and there was a fight in which the dogs were cut badly. When they separated a little, Mr. Burton killed one of the wolves with a charge of heavy shot. The other barrel of the gun missed fire and one wolf escaped.

McCoysburg, Jasper County, C. W. Bussel killed or captured 10 in the winter of 1903-4. He also killed two May 16, 1906, which are now in the National Museum at Washington, their numbers being $\frac{143633}{49889}$ and $\frac{143634}{49890}$. I do not know how many others may have been killed by Mr. Bussel. L. Darrow killed five in Laporte County in 1903-4. At one time he saw eight in a pack and at another time 20. He regards them as crosses between the coyote and timber wolf.

Near Leesburg, Kosciusko County, Mr. R. E. Gunter reports five killed by John Harmon, James Hamilton, Jefferson Plummer, Arthur Hoffein and Sam Griffith. A pack of moderate size was seen in the winter of 1906-7. None weighed over 45 pounds and they are there regarded as prairie wolves. There have been wolves reported from other localities also but I have not been able to verify these reports.

Habits.—It will be seen from the foregoing account that this species has in some way been rejuvenated in Indiana in recent years. I am unable to give any definite reason for this. Mr. Burton, who has hunted and trapped in the Kankakee marshes for about four decades, says that the wolves were formerly common and were hunted by men on horseback. This method was so successful that their numbers were greatly reduced. In recent years the marshes have been fenced for grazing land and hunting on horseback has become impossible.

I do not believe this will fully account for their increase. The early settlers have little to say about the cunning of either species of wolf. At the present time the general opinion seems to be that of one correspondent who says of the coyote, "he can discount the fox for cunning." Members of the dog tribe have everywhere and always been able to better adapt themselves to man than any

other carnivora, as is evidenced by the dogs of most savage tribes; the different breeds have probably sprung from several different stocks.

The coyote of the old days was unacquainted with cultivated fields, domestic animals, traps and guns. Hence he was sometimes too bold and too open in his attempts to get food from the farmyard. Consequently the race was reduced in numbers. The remnant, which for several decades led a precarious existence in the inaccessible swamps, were timid and cautious. At last they found that they could secure food about the farms under certain conditions. They again became bolder, but at the same time were cautious. They fared better now and increased in numbers, and at the same time advanced in knowledge of traps and guns. The present generation are bold, yet cunning, and there is apparently little hope of exterminating them completely except by draining swamps and reducing all of the land to cultivation. Even then it is probable that some, like the foxes, will remain in rough ground along creeks and rivers. They have extended their ranges in the last five or six years, and there is danger that they will spread over the entire State unless vigorous measures are taken to check them.

All correspondents agree that they are very destructive to poultry, pigs and lambs, as well as game. Mr. Darrow says: "A region where they are abundant is almost destitute of game." Mr. Bussel says: "They are especially destructive to turkeys. They would kill a flock of 50 turkeys and leave most of them lying on the ground, possibly eating one apiece. * * * There is no doubt in my mind but what these wolves have destroyed thousands of dollars worth of poultry, lambs and pigs."

Their method of killing, like that of the larger wolves, is to give a slashing cut with the teeth, not holding on, but slashing and dodging. This is what makes them so destructive to a flock of poultry, and a large flock will be destroyed in a few minutes by the animals dashing among them and biting right and left. They use the same method in fighting, and hence are more than a match for a dog of their own size and strength. They hunt in packs and capture their prey in the open chase like the timber wolves.

The mating season is in February, and the young are born between the first and 15th of April. A burrow is usually dug by the parents in a high place in the prairie, where the adults can lie at the entrance and keep an outlook for danger. Sometimes the den is in a hollow log in the more open woods.

According to Mr. Bussel, the young, which number from five to eleven, are moved about a great deal after they are a month old. He says that it is almost impossible to find the dens because they are moved every time a man or dog comes near. A single dog venturing too near the den, will be attacked by both of the old coyotes and badly injured or killed.

Family MUSTELIDAE.

MINKS, WEASELS, SKUNKS, BADGERS, OTTER, ETC.

Carnivorous animals of small or medium size, with digitigrade feet and claws partially or not at all retractile; five toes on fore and hind feet; anal glands which secrete a fetid fluid, often present.

This family contains more genera and species than any other in the order *Ferae*, and is found in all parts of the world except the Australian region. As the common names indicate, the species differ very greatly in appearance and also in the anatomical characters which fit them for different modes of life. Some are almost wholly arboreal; others burrow into the ground and some are aquatic, the sea otter being better adapted to aquatic life than any other mammal excepting the whales and seals.

The family is generally divided into several subfamilies and 20 or more genera. Ten or more genera occur in North America, eight of which are recorded from Indiana.

Genus Lutra Erxleben.

Lutra Erxleben, Syst. regni animal, I, p. 445, 1777.

Dental Formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{4-4}{3-3}$; M, $\frac{1-1}{2-2}=36$.

Generic characters.—Toes webbed, with small curved claws; head very broad and flat; tail thick at the base and tapering toward the tip; fur very dense, short and generally colored plain brown; habits aquatic.

The genus has a distribution nearly as wide as that of the family, but does not contain a great number of species. About seven forms are now recognized in North America. There is a little uncertainty as to just which of the subspecies occurs in Indiana, and it is even possible that the otter of the Lower Wabash Valley differ from those of the Kankakee Valley. The point can not be easily determined at the present time.

LUTRA CANADENSIS LATAXINA (F. Cuvier).

SOUTHERN OTTER.

Lutra lataxina F. Cuvier, Dict. des Sci. Nat., Vol. 27, p. 242, 1823.

Lutra hudsonica Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 138, 1894.

Lutra canadensis Hahn, Proc. U. S. Nat. Mus., Vol. 32, p. 463, 1907.

Diagnostic characters.—Toes webbed; color yellowish brown; habits aquatic.

Description.—The characters said to distinguish this subspecies from the northern otter, *L. canadensis,* are the lighter color and more sparsely haired webs on the soles of the feet. The body bears some resemblance to that of the mink in shape, but is much larger. The head is broad and flat, with the muzzle naked for a quite a large space. The ears are small and rounded; legs very short and feet very broad, the tips of the toes forming a semicircle when outspread. In southern specimens they are nearly naked underneath, while in the northern race they are densely furred.

In addition to geographic reasons for assigning the Indiana otter to the subspecies *lataxina,* Baird describes one from Fort Wayne,* saying that it has less hair on the under side of the feet than one from Washington City. The latter is *lataxina* and the lack of hair on the soles of the Indiana specimen would seem to indicate that the characters of the southern form are even more pronounced in the Indiana otters.

Measurements.—Miller gives the following: Total length, 1,100 mm. (43¾ in.); tail, 420 mm. (16½ in.); hind foot, 125 mm. (5 in.). Baird gives the total length of the specimen mentioned above as 49 inches.

Skull and teeth.—The skull (fig. 15) is remarkably wide in proportion to its depth. The rostrum is very strong and consequently does not lack much of being as deep as the braincase; braincase broad and tapering to a distinct constriction back of the orbits; postorbital processes short, broad and strong and placed very far forward relative to the zygomatic arches; last upper premolar and true molar both broad and strong, but not marked with strong projections or cusps.

Range.—This subspecies was formerly found from the Gulf States about to the Canadian border and from the Atlantic at

* In the table of measurements he gives this locality as "Fort Wayne, Ark.," but there is good reason to believe that this is a misprint and that Fort Wayne, Indiana, is intended.

least to the Rocky Mountains. At the time the State was first settled by the whites, otters lived along all of the larger water courses. They have been rare for many years, but are not yet entirely exterminated.

The Prince of Wied states that otter were abundant along the Wabash at New Harmony in 1832-33; he mentions a pure white one taken on the Mississippi. A specimen was taken near New Harmony in the winter of 1906-07. Mr. Robert S. White says that otter still live along Pigeon Creek in Warrick County. Mr. Chansler says "a few are still taken in the southern part of Knox County, but they are about extinct. In the early days they were common, and peopled killed them in the snow as they traveled from one pond to another. A snow white one was caught in a trap near Vincennes in March, 1902. Another white one was caught by Mr. M. Arm-

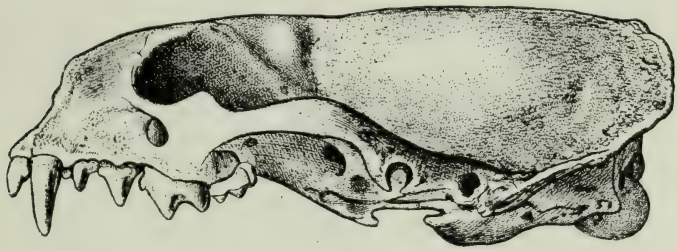


FIG. 15.—Skull of *Lutra canadensis lataxina* from Washington, D. C. After Baird.

strong south of Vincennes, December 17, 1905." I am unable to learn that white otters are generally common and it would seem that the albinistic quality may be an hereditary character of certain otters in that vicinity. An otter in the State Museum was taken in Pike County in 1904. Mr. Blatchley reports it from Putnam County in 1871.

Dr. Plummer says otters were very scarce about Richmond in 1844. In 1869, Haymond states "that it is barely possible that a few still linger along the Whitewater (Franklin County). None have been seen for many years." Prof. Van Gorder states that the last otter in Noble County was killed near Skinner Lake in 1863.

Along the Kankakee they have remained until very recent times, perhaps still exist, although the draining of the swamps is rapidly exterminating them. Mr. I. W. Burton saw one which was taken near Roselawn in the winter of 1903-04. The skin sold for $11.50.

Habits.—Fish constitute the principal food of otters. They pursue them actively, swimming and diving with great agility, and

even catching such active members of the finny tribe as trout and salmon. They resemble seals in their movements in the water, and are equally graceful and playful. They are more active on land than their form would indicate, for the legs are so short that the body drags the ground when walking. Where they travel in the snow the body scoops out a furrow along the path.

Otters do not hibernate during the winter, but seek out springs and the swift places in streams where the water does not freeze. They also fish under the ice, and in the far north are said to stay under the ice for hours at a time. At all seasons, they travel from stream to stream, and they seem to follow somewhat regular routes. They are sometimes away from home for several weeks, and appear to have regular stopping places along the way. They are sociable, and a pair, or even a whole family, are often found together.

These animals are fond of sliding down embankments, and wear furrows on the banks of streams where they resort frequently for this sport. In winter snow freezes to their wet fur and enables them more readily to slide down declivities to which they come in their wanderings, and they always take advantage of this, and walk up hill and across level places, but slide down all inclines.

Some observers think that otters remain mated for life. At any rate, the pair remains together during the summer, and the male assists in caring for the young. From one to five is the number in a litter. It is said that the young are afraid of the water, and that the mother carries them in by force when she is teaching them to swim.

The home is in a burrow in the bank of a stream. Rhoads has given us an account of a very extensive one which he examined. A chamber "large enough to hold a horse and cart" was broken into by some workmen excavating brick clay. It was in a high bluff overlooking a marsh and seventy-five yards from a creek. An underground tunnel probably led beneath the marsh to the creek. Mr. Rhoads thinks the chamber "probably had been dug hundreds of years ago," and that "it is possible the large amount of earth thrown out by the otters was the ultimate cause of the obstruction of the creek and its final abandonment of that channel for the one now occupied on the opposite side of the marsh."

The fur of the otter has always been highly prized, and it has resulted in great persecution of the animal by trappers. Only the shyness of the otters has prevented their complete extermination.

Genus MEPHITIS Geoffroy & Cuvier.

Mephitis E. Geoffroy & Cuvier, Mag. Encyclop., Vol. 2 (6), p. 187, 1795.

Chincha Howell, N. A. Fauna, No. 20, p. 14, 1901.

Dental Formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{3-3}{3-3}$; M, $\frac{1-1}{2-2} = 34$.

Generic characters.—Form stout, the body being especially heavy behind; nose pointed; ears rather small; legs long. The color is always black and white and the white is usually in two broad stripes along the middle of the back (Plate 5, fig. 1); sometimes the stripes are joined into a single broad band; often there is a spot or spots of white on the head; occasionally the animals are entirely black. Anal glands are highly developed and are surrounded by muscles which can contract and eject the extremely offensive fluid secreted by the glands to a distance of four or five yards from the animal.

The genus is restricted to North America, where it is represented by some seventeen or eighteen species and subspecies. Two of these are found in our State. They are distinguished principally by the form of the posterior border of the bony palate.

Palate with a short, blunt spine (Plate 6, Fig. 2) projecting from the middle of its posterior border. *M. putida.*

Palate cut off squarely (Plate 6, Fig. 4) or a little notched in the middle. *M. mesomelas avia.*

MEPHITIS PUTIDA Boitard.

EASTERN SKUNK.

Mephitis putida Biotard, Jardin des Plantes, Mamm., p. 147, 1842.

Mephitis mephitica Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 136, 1894.

Chincha putida Howell, N. Am. Fauna, No. 20, p. 25, 1901.

Diagnostic characters.—Distinguished from the next species by the small process at the posterior border of the palate and by its smaller size and longer tail.

Description.—The color is always black and white or entirely black, the amount of white being extremely variable. In some animals it consists of two rather narrow stripes separated, except on the neck and shoulders, by a median black line. On others, the white covers most of the back and may extend along the sides of the tail. There is sometimes a broad band of white on the head; in other individuals the white of the head is reduced to two small

1

2

PLATE V.—Fig. 1, skin of large skunk, *Mephitis putida*. Fig. 2, skin of small striped skunk, *Spilogale putorius*. Both after Howell, N. Am. Fauna Nos. 20 and 26, Bureau of the Biol. Sur., U. S. Dept. of Agri.

spots (the star skunk of fur dealers). Some individuals are entirely black on the head and body, but I have never seen any in which the white tip of the tail was lacking. Size smaller and tail longer than the next species.

Measurements.—Howell gives the average of six males from New York as follows: Total length, 575 mm. (23 in.); tail, 229 mm. (9 in.); hind foot, 60 mm. (2⅜ in.). The females are larger and six from the same locality average: Total length, 603 mm.; tail, 223 mm.; hind foot, 62 mm.

Skull and teeth.—The skulls of the skunks, like all other members of the family, are very compactly built. Most of the bones become fused at an early age and they are thick and strong. The skull of this particular species (Pl. VI, figs 1 and 2) is broad across the zygomatic arches and the small posterior process in the middle of the palate is peculiar to it. However, this spine is reduced or wanting in the females.

Range.—From Virginia to southern New England and west to Indiana. In this State, according to Howell, its range meets that of the next species, but the two do not intergrade. I am unable to give the limits of distribution for the two forms, the only record for the Illinois skunk being that of Howell from Benton County. The present species appears to be the one occurring throughout most of the State.

The opinion of most of my correspondents seems to be that skunks are growing scarce. However, I feel quite sure that these animals are as abundant or more abundant about my boyhood home in Ohio County than they were twenty years ago. Evermann and Butler state that they were still abundant in Franklin County in 1893. I do not think that they have been completely exterminated in any county of the State.

Habits.—Last summer, while setting traps for field mice in an old pasture, I noticed a great many small, conical holes going down through the grass and into the hard ground for an inch or two. It was evident that some animal had been searching for grubs and insects there. I was uncertain at first as to what sort of animal had been doing the work, but one evening about sun-down I saw a large skunk come out of a sinkhole and begin nosing around in the grass.

I watched it for some time, going up to within eight or ten yards of it (I feared to go nearer). It went about, watching me over its shoulder and appearing uneasy because of my presence, but not running away. It would thrust its nose down through the

PLATE VI.—Skulls of skunks: 1 and 2, *Mephitis putida;* 3 and 4, *Mephitis mesomelas.* After Howell, N. Am. Fauna No. 20, Bureau of the Biol. Sur., U. S. Dept. of Agri.

close mat of short blue grass, apparently being able to make a hole into the hard earth with its snout alone, although it used both claws and teeth to work deeper when necessary. I could not see what it was eating, but grubs and other insect larvae were probably abundant there. When I clapped my hands and shouted, it turned and went slowly back to the sinkhole, standing in the entrance a moment and then retreating further when I threatened it again.

Had I ventured to strike at it with a club I might have had the whole story of its activities and mode of defense—but I preferred to omit the final chapter.

Insects constitute a large part of the food of these animals. In the tobacco growing region of the State they are indefatigable in their search for tobacco worms. Unfortunately, they are so clumsy that they break more leaves from the tobacco to get one worm than a dozens worms would eat in an entire summer. But they destroy cutworms in the cornfields and grasshoppers in the meadows without causing damage there. Besides insects, they eat mice, snakes, lizards, frogs, young birds and birds' eggs, as well as some vegetable matter. Sometimes they raid a poultry yard, but this does not happen often nor do they destroy many birds.

Their means of defense is one of the most effective ever devised by nature, and no animal likes to brave their malodorous discharge, although some of the larger carnivores will do so when driven by hunger. The smell of the skunk is very penetrating and very enduring. Contrary to popular belief, it is not the urine, and never enters the bladder, but is secreted by a pair of glands lying along the rectum and is dscharged from them through the anus.

Skunks have come to rely implicitly on this fetid discharge for protection, and will not get out of their way for any animal, large or small. I have known a horse, ridden by a man, to stumble over one in the road, and the skunk came off with the least damage. I have also heard a true story of a young German farmer, who had not yet become acquainted with our animals, attempting to pick up one of these pretty "cats" to take home as a pet for his children. The skunk allowed him to place his hands on it out in the open field, but he decided not to take it home to the children. The fearless little brutes like to make their homes near a human dwelling, and it is said that a family of them was found residing under the front veranda of one of Indiana's most noted college presidents.

On account of their sluggishness, due principally to immunity from danger, they have been compelled to resort to an insect diet,

supplemented by vegetable food and now and then small birds or mammals. Since most of the things they eat are dead or hidden deep in the ground during the winter, skunks hibernate for several months, coming out, however, in February or March. Perhaps the excessive fat they acquire in the fall also has something to do with their hibernation. Often several individuals den up together. I have known of seven being dug from a small sinkhole in Switzerland County in February, and a still larger number is sometimes reported. They do not always remain inactive, even till February, but sometimes leave the den and return to it after a foraging expedition. It is at this time of the year that poultry yards are most apt to suffer.

They are generally nocturnal in habits, although they sometimes venture out in daylight. Wied says that they were more active during the day on the Upper Missouri than in the inhabited regions. Their meat is said to be tender and white like that of a young chicken, and very palatable if the scent glands are removed as soon as the animal is killed. However, not many white people would have the courage to eat it.

The young are born in April or May and there may be as many as eight in a litter. The female cares for them during the summer and teaches them all of the lore of their ancestors. The white colors of the parent no doubt serve as recognition marks by means of which the little ones are able to follow their mother in the darkness.

MEPHITIS MESOMELAS AVIA (Bangs).

ILLINOIS SKUNK.

Mephitis avia Bangs, Proc. Biol. Soc. Wash., Vol. 12, p. 32, 1898.
Chincha mesomelas avia Howell, N. A. Fauna, No. 20, p. 30, 1901.

Diagnostic characters.—Tail shorter in proportion to the body than in the eastern skunk; palate without a posterior spine.

Description.—As this species is only a little less variable than the eastern skunk, individuals of both species may be found with exactly the same markings. In general, the Illinois skunk has less white than its eastern relatives, and the white tip of the tail is small or wanting. The species are very distinct, however, as their skulls and proportions show.

Measurements.—Howell gives the following as the average of two adult males from San Jose, Illinois: Total length, 641 mm. (25½ in.); tail, 184 mm. (7⅜ in.); hind foot, 65 mm. (2⅝ in.).

Skull and teeth.—Skull rather small and narrow, with the palate ending squarely behind, without a spine projecting backward (Pl. VI, figs. 3 and 4); teeth smaller than in the eastern skunk.

Range.—This subspecies is known only from Indiana, Illinois and Iowa. It is more closely related to forms to the southwest than to the eastern skunk.

The only positive record from Indiana is the one given by Howell for Fowler, Benton County. It is very probable that this is the species inhabiting all of the northwestern part of the State, but the material necessary to determine this point is not at hand.

Habits.—I know of no way in which the habits of this species differ from that of the other, although its home is on the prairies and undoubtedly it lives a somewhat different life from the skunks of the rocky hills and woods. In the Kankakee Valley I learned that the skunks generally occupy deserted woodchuck holes.

Genus SPILOGALE Gray.

Spilogale Gray, Proc. Zool. Soc. London, 1865, p. 150. Howell, North. Amer. Fauna, No. 26, 1906.

Dental Formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{3-3}{3-3}$; M, $\frac{1-1}{2-2}=34$.

Generic characters.—Form rather slender; skull relatively broad and flat; highly developed glands connected with the rectum. The color is always black and white, and although the pattern is not the same in different species, the white is always divided into at least four nearly parallel stripes on the upper surface of the body or a number of spots (Pl. V, fig. 2); it is never united into one or two white bands as in *Mephitis*.

SPILOGALE PUTORIUS (Linnaeus).

ALLEGHENIAN SPOTTED SKUNK.

Viverra putorius Linnaeus, Syst. Nat., Ed. 10, p. 44, 1738.

Mephitis putorius Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 139, 1894.

Spilogale putorius Howell, N. Amer. Fauna, No. 26, p. 15, 1906.

Diagnostic characters.—Body black, with four white lines, or rows of white spots on the body.

Description.—Form more slender than the common skunks, less slender than the weasels; body black with the exception of one or more white patches on the forehead, four white stripes running from the back of the head to the posterior part of the body, some white spots on the rump and flanks and the tip of the tail. The

prairie spotted skunk (*Spilogale interrupta*) is similar, but has much less white.

Skull and teeth.—The skull of this species is long and narrow compared with the other members of the genus, although the general form is much like that of the large skunks. The zygomatic arches are widely spreading and the teeth are heavy.

Measurements.—Howell states that seven adults vary from 470-563 mm. (18¾ in. to 22½ in.) in total length; tail, 193-219 mm. (7¾ to 8¾ in.); hind foot, 45-51 mm. (1¾ to 2 in.).

Range.—*Spilogale putorius* has previously been known in the southern Appalachain region and Gulf States, the nearest records being from Tennessee and West Virginia. I am indebted to Mr. E. J. Chansler, of Bicknell, who has furnished me with so many valuable records, for all the knowledge I have concerning the occurrence of this species in the State. In his list of Knox County mammals first sent to me in April, 1907, Mr. Chansler mentioned the "civet cat," saying that a fur dealer who formerly resided in Vincennes stated that he had obtained a few "civet cats" from the southern part of the State. He stated that they had several curved white stripes and spots on the body. The civet family (*Viverridae*) are not inhabitants of America at all, and at my request Mr. Chansler set about getting further information. In reply to his inquiries Funsten Brothers Company, of St. Louis, one of the largest dealers in raw furs in the United States, stated that they obtained a few civet cat skins from Indiana and they further gave him an accurate account of the range of the genus *Spilogale* and a brief but accurate statement concerning some of its different species. Andersch Brothers, of Minneapolis, also informed him that they obtained a few civet cats from this State.

A more definite record, and one which seems to certainly establish the occurrence of these animals in the State, is the capture of a "civet cat" near Overshot bridge on the Vandalia railroad, between Bicknell and Bruceville, in Knox County. Although the skin was not seen by any trained naturalist, the man who trapped the animal reported it to Chansler and stated that he received a small price for it, as the fur was in poor condition. I have learned from several fur dealers that the skins of these skunks are handled under the trade name of "civet cats" and there does not seem to be any possibility of confusing them with other animals. Moreover, all of the fur dealers consulted have been able to give identifiable descriptions of the animals and definite information as to their distribution. It is certain that these skunks are very rare in the

State, but I believe that the above facts are sufficient to record the species, although I have been wholly unable to secure specimens.

There may be some question as to the specific identity of the animals mentioned, but I think the description, "curved stripes and spots on the body" makes it much more probable that the species is *putorius* than that it is *interrupta*. The known distribution of the species also makes the former the more probable. There is, of course, a possibility that they may be a form at present unrecognized.

Habits.—The habits are much like those of the large skunks (*Mephitis*). They are more slender and active and climb trees more readily. They also appear to be more strictly flesh eaters, although they are known to eat insects at times.

According to a number of observers, they are easily domesticated, and in some localities are welcome residents of the barn or cellar, because they drive away or kill the rats and mice. However, they are equally fond of chickens, and can not be given much freedom where poultry is unprotected.

Genus TAXIDEA Storr.

Taxidea Storr, Prod. Meth. Mamm., p. 34, 1780.

Dental Formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{3-3}{3-3}$; M, $\frac{1-1}{2-2} = 34$.

(In the young animals there is an additional premolar in the lower jaw.)

Generic characters.—Body very broad and stout; legs and tail short; claws of fore feet very long; color grizzled grayish or brownish; skull very wide posteriorly.

This genus is confined to North America, the European badgers being generically distinct. It contains but a single species which is separable into four subspecies. Only one of these occurs east of the Mississippi.

TAXIDEA TAXUS (Schreber).

AMERICAN BADGER.

Ursus taxus Schreber, Säugethiere, III, p. 520, 1778.

Taxidea americana Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 137, 1894.

Diagnostic characters.—Those of the genus; the only animal for which it could possibly be mistaken is the woodchuck. It is easily distinguished from the latter by having six small front teeth above and below instead of two large ones.

Description.—The legs are very short and placed wide apart so that the body is carried low and, except for the fact that the back is somewhat rounded, the animal looks as though it had been stepped on and mashed. The back is always grizzled with black and yellow, but the color varies greatly. In some individuals the general effect is a deep, rusty brown; in others it is paler yellow and in some a gray, not dissimilar to that of the rabbit; middle of back darker, as are also the sides of the face and legs; white line from the nose to the top of the head or nape of the neck. The hair is coarse and long.

Measurements.—I have no detailed measurements. The total length as given by Baird is about 27 inches; tail 5 inches.

Skull and teeth.—The skull is broad and flat, bearing some resemblance to that of an otter in its general shape. However, the zygomatic arches are not so spreading and the braincase is as broad as the arches. The teeth are strong, the upper molars being rounded, the last upper premolar large and triangular and the others small and simple. The outer upper incisor is considerably larger than the other two.

Range.—From Ohio west to the Rocky Mountains or farther. Some of the subspecies are found throughout all of western North America, from southern Mexico to about 55 degrees north latitude.

The badger has never been very abundant in Indiana. Evermann and Butler give the following localities and dates: One killed five miles south of Newport, Vermillion County, in 1880. One was caught in Lagrange County in 1887, and three others in the same county within a few years previous. One was caught in the eastern part of Elkhart County in 1888. In 1880 a black one was taken in Noble County. July 28, 1889, a badger was killed near Metamora, Franklin County, and two others were said to have been killed in 1888. These authors also report it from Grant, Kosciusko, Steuben and Dekalb counties. Butler later reported it from Newton County.

I have very little to add to this record. Prof. Van Gorder says the badger was supposed for a long time to be extinct in Noble County, but that he saw one taken in Green township in the spring of 1895, and one or two have been reported in the county since that time. Mr. I. N. Lamb saw one near English Lake in 1871. Mrs. Anderson mentions their occurrence in Benton County and Mr. Upson saw one in Lagrange County in the spring of 1908.

Habits.—The badger digs extensive underground tunnels in the prairie. He is a nocturnal animal and is seldom seen in the day-

time. The color of the animals is well suited to protect them from observation.

This protective coloring is probably of as much use in enabling them to creep up on their own prey as it is in enabling them to escape enemies. The larger beasts of prey probably get them now and then, but they are very strong and are a match for a good-sized bulldog in a fair fight. Their food consists of small mammals and probably snakes and frogs as well as insects. They are thus useful in destroying noxious rodents and in some places help greatly in reducing the number of prairie dogs and pocket gophers. They dig open the burrows of these animals and drag them out by force. Badgers hibernate during the cold months.

Genus Gulo Storr.

Gulo Storr, Prodr. Meth. Mamm., p. 34, 1780.

Dental Formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{4-4}{4-4}$; M, $\frac{1-1}{2-2}$ = 38.

Generic characters.—Body stout; legs, ears and tail short, the latter bushy; most of the sole applied to the ground in walking as in the bears. The genus is represented by only two living species, one in the northern part of North America and one in the northern part of the old world.

GULO LUSCUS (Linnaeus).

WOLVERENE; CARCAJOU; GLUTTON.

Ursus luscus Linnaeus. Systema Naturae, ed. 10, p. 47, 1758.

Description.—Color dark brown, with a yellowish white band running from behind the shoulders up to the rump and joining a similar band from the opposite side; similar patches occur on the head and under the breast; feet and face blackish. The hair is long, especially on the tail, and both head and tail are carried low, after the fashion of a low-spirited dog. The body is much more clumsy and thickset than that of any other member of the family. The skull and teeth are large and powerful.

Measurements.—Miller gives the following: Total length, 760 mm. (30 in.); tail, 200 mm. (8 in.); hind foot, 170 mm. (6¾ in.).

Range.—Northern North America, formerly south to the United States. It will doubtless be a matter of surprise to many that this animal should be included in the fauna of Indiana. I have hesitated somewhat over the evidence, but as there are two well attested, though unpublished, records from widely separated parts of the State, I can not pass over them. Prof. Van Gorder says: "In

1840 an animal was shot in Washington Township (Noble County), which at that time was named the wolverene, the only one reported to have been seen in the county."

Concerning its occurrence in Knox County, Mr. Chansler writes: "As strange as it may seem for this animal to be caught this far south, Mr. N. B. Bruce declares that a Mr. Simondson killed one of them near Edwardsport, this county, in 1852. I questioned him and he gave its size, color, form and general makeup all right. What it was doing as far south, I am at a loss to know."

I have less hesitation in recording the wolverene on the basis of such reports than I would have for most other species of mammals. Its form, size, and color are so different from any other animal that could possibly occur in the State that there seems to be no chance for a mistake. This is the more true because in the days when these animals were reported, the pioneers were familiar with every beast of the woods. Moreover, there is a definiteness about the reports which makes them creditable, the statements in each case being that the animal was *killed* at a certain place in a certain year. The evidence of its occurrence in Indiana is almost exactly parallel to that given by Rhoads for Pennsylvania, and is, I think, quite as strong, although Indiana is somewhat more remote from the known range of the species than the latter State. In his native forest, the wolverene is a great wanderer, and the animals found in this State were without doubt strays.

Habits.—Probably no animals, not even snakes, are so universally detested as is the wolverene in the great north, where he is best known. Many a voyageur who has left a well-built cache of food for a time of need, returns to find the store broken open and a part of it eaten and the rest defiled by the filth which this animal deposits on surplus food to prevent others from using it. So offensive are the odors and substances which he deposits on this food that no other animal of the forest, however hungry, can eat it.

His very method of hunting makes him seem despicable. He can not climb trees like the more agile members of the family to which he belongs; and he has neither the speed nor the cunning to capture the swift creatures of the wood in a fair race. Therefore, he feeds on offal, carrion, or lamed, starved or entrapped animals and on such food as he can steal in one way or another.

Another habit which makes the species universally hated by the men of the north is that of systematically following a line of traps for the bait or the animals which have been caught. In this way a great number of traps are sprung or destroyed and many a

valuable skin is made worthless. Nor is this robber easily captured. He seems to have an instinctive knowledge of traps which enables him to spring them without running any risk of being caught. Indeed, only the strongest wolf or bear trap will hold him.

The strong claws and powerful muscles enable him to dig with great rapidity, and not only the homes of mice and other humble creatures, but even fox dens are opened and the cubs of the latter eaten. During the summer, he is less offensive, and frogs, snakes, mice, birds and birds' eggs are the staple articles of food.

The one redeeming character of this animal is the solicitude which both parents exercise for their young. From three to six of these are born each year, in June or July, in some sort of underground burrow. The family remain together for several months, and the young are defended with great courage. At other seasons the wolverene is generally solitary.

Genus LUTREOLA Wagner.

Lutreola Wagner, Schreber's Säugethiere, Suppl., II, p. 239, 1841.

(*Lutreola* has been regarded as a subgenus of *Putorius* by writers in the past. I have followed Dr. Merriam and some other recent authors in treating it as a full genus.)

Dental Formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{3-3}{3-3}$; M, $\frac{1-1}{2-2} = 34$.

Generic characters.—Color nearly uniform brown all over, with a white spot on the chin and sometimes on the chest. Never white in winter. Feet webbed. Size larger than that of the weasels, smaller than the otters, to which the minks bear some resemblance.

This genus is limited to the northern hemisphere. About six forms are recognized in North America. Only one occurs in this State.

LUTREOLA VISON LUTREOCEPHALUS (Harlan).

SOUTHEASTERN MINK.

Mustela lutreocephala Harlan, Fauna Americana, p. 63, 1825.

Putorius vison Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 137, 1894.

Lutreola vison McAtee, Proc. Biol. Soc. Wash., Vol. 20, p. 6, 1907.

Hahn, Proc. U. S. Nat. Mus., Vol. 32, p. 463, 1907. Vol. 35, p. 576, 1908.

Diagnostic characters.—Color dark chestnut brown, with a white spot on the chin and another between the fore legs. Length about 27 inches.

Description.—The mink resembles the otter quite closely in form of body, but the legs are proportionally longer and the animal is more active on land. The color is darker and the tail is about one-third as long as the head and body; outer third of tail darker in color.

Measurements.—Miller gives the following: Total length, 635 mm. (25 in.); tail, 210 mm. (8¼ in.); hind foot, 70 mm. (2¾ in.). The size varies greatly, and I have seen a few minks very much above the average size. I am not absolutely sure that these large ones may not be a distinct species, although they have not been recognized as such. One of unusually large size was taken near Hazelton in 1908.

Skull and teeth.—The skull is compact like that of all other *Mustelidae.* The bony palate extends considerably farther back than the rather short tooth row and is V-shaped behind instead of being somewhat square as in the skunks. There is a considerable space between the outer upper incisors and the canines. The upper molar is broader (transverse to the skull) than long, and the last upper premolar has three prongs, making it somewhat Y-shaped.

Range.—This subspecies has a range extending from the Gulf States to southern Canada. Other minks are found throughout most of the country from Mexico to the Arctic Ocean.

Minks were once numerous throughout most of Indiana. They have been trapped and hunted for their fur to such an extent that they are now considerably reduced in numbers, but even yet are by no means rare where swamps and woods remain. In 1893 Butler saw three in daylight, playing about a drift pile along a little stream within the corporate limits of Brookville.

Habits.—These animals are very perfectly adapted for a life of activity, danger and destruction. In the water they swim and dive with the agility and speed of an otter. On land, they hunt with the stealth of a cat and run with the speed of a coyote. They are instinctively timid, and do not blunder into traps with the stupidity of a rodent, but they never learn to keep away from habitations or to avoid the smell of man and iron, in this way seeming unable to profit by experience, as do foxes and coyotes. This latter fact probably has more to do with the diminution of their number than does the great amount of persecution.

Referring to their speed and ability to hide anywhere, Stone and Cram say: "I have seen them disappear instantly among the dry oak leaves that carpet the open where hardwood grows, and they will do the same thing in short thin grass or shallow snow with a suddenness that leaves the beholder wondering. At such times, if they deign to show themselves again, it will in all probability be several rods at least from where they first disappeared, and then perhaps only for the briefest glimpse.

"Only yesterday I was sitting beneath a sheltered bank, warmed by the thin sunlight of late November and well out of the reach of the roaring north wind, when I heard a rustling among the leaves eight or ten rods away. Looking toward the sound, I saw, just for an instant, a beautiful little female mink with the sun full on her back, then saw only the russet-colored leaves sloping up between the tree trunks; but even while I looked there was the mink again, several rods farther away and just in the act of vanishing as before.

"I squeaked like a mouse to call her, but the wind was so loud in the trees that I failed to make myself heard; so I imitated the chatter of a red squirrel as closely as I could, and instantly the mink came skipping toward me over the ice of a little pond that lay between us.

"I do not think that I have ever seen any other four-footed creature, not even a deer or a fox, run with such baffling swiftness. I could just catch one image of her coming, head up across the sunlit ice before she disappeared in the sere frozen water grass almost at my feet."

As already indicated, minks obtain much of their food from the water. They swim with enough speed to enable them to catch fish, of which they are very fond, and in addition they eat crayfish and mollusks. They destroy great numbers of mice and also many of the smaller game animals, such as muskrats, rabbits and squirrels. Song and game birds are also killed. However, the greatest harm done by these animals is in the poultry yards. Prof. Cox has recorded the killing of 24 half-grown chickens by a mink in a single night. I have heard of one of the animals killing twelve chickens one night and seven in the same poultry house the next night. In both instances the animal was frightened away or might have killed more. Where they come upon such a supply of food as this, they never eat much of the flesh, but suck the warm blood. They travel long distances in search of food. One hunter writes

me of following a mink track nearly all day in the snow, traversing about 20 miles, and finally ending at a den not far from where he started.

With so many harmful qualities added to the value of its fur, it is no wonder that minks are killed wherever possible. The fur makes the animal one of considerable economic value, and its extermination is not desirable. Partially successful attempts have been made to raise the animals in colonies or "minkeries," and it is to be hoped that other ventures of the same sort will be made with this and other fur-bearing animals. Minks are relatives of the ferrets, and can be tamed and used to exterminate rats and other noxious rodents.

The young vary greatly in number. From four to six is probably the more usual size of the litters, although Marfarlane states that as many as 12 have been observed in northern Canada. The den is sometimes in a hollow log, but most often in a burrow in the bank of a stream.

Considering the fecundity of the species, the security of the young in their underground homes and the ability of the adults to secure food and to escape being food, it is difficult to see why the species did not become even more abundant than it was before the country was settled by whites. However, the competition for food was greater then than now, for although some of the animals which mink eat have been reduced in numbers, the larger carnivores which depended in part on the same food have almost wholly disappeared.

Genus Putorius Cuvier.

Putorius Cuvier Regne Animal, I, p. 147, 1817.
Merriam, N. A. Fauna, No. 11, 1896.

Dental formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{3-3}{3-3}$; M, $\frac{1-1}{2-2} = 34$.

Generic characters.—Species smaller than those of *Lutreola*, which they resemble in many ways; color generally paler on the under side than on the upper, often changing to white in winter; body slender and tail also more slender than in *Lutreola*.

This genus contains both the ferrets and weasels and species belonging to it are found in all of the continents except Australia. The ferrets constitute a distinct subdivision and are represented in North America by a single native species on the western plains. On the other hand, more than 30 species and subspecies of weasels occur north of Panama. Only one form is known to occur in Indiana.

PUTORIUS NOVEBORACENSIS Emmons.

NEW YORK WEASEL.

Putorius noveboracencis Emmons, Report on the Quadrupeds of Massachusetts, p. 45, 1840.

Merriam, N. A. Fauna, No. 11, p. 16, 1896.

Putorius erminea Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 137, 1894.

Diagnostic characters.—Tail about one-half the length of the head and body together; color brown above and white below, sometimes becoming white all over in winter.

Description.—The size is smaller and the body is relatively more slender than that of the mink, and it is carried higher above the ground. The color is slightly paler above and the white extends all along the under side of the animal and generally includes part of the upper lip also. Tail with a black tip, even in winter when the rest of the fur sometimes becomes pure white. This change to the white coat is always due to the shedding of the hair and so is the return to the brown coat in spring; the hairs do not change color. In the spring and fall the animal is sometimes mottled and spotted, while the molt is taking place, but the change does not require a very long time.

Measurements.—An adult male from Mitchell measured: Total length, 400 mm. (16 in.); tail, 125 mm. (5 in.); hind foot, 45 mm. (1¾ in.). A male from Hebron is somewhat smaller, measuring but 387 mm. in total length. Females are always much smaller, the average being only 324 mm.

Skull and teeth.—The skull of this species is large for a weasel, with long, narrow audital bullae and rather straight zygomatic arches. Teeth much like those of the mink, but smaller and with differences in the details of their shape.

Range.—The range of the species, as defined by Merriam, extends from Maine to North Carolina and west to the Mississippi. Since Dr. Merriam's revision of the genus, a subspecies has been described by Bangs from North Carolina as *Putorius noveboracensis notius.* It is said to differ from the typical form in having the under parts yellow instead of white and in not changing to the white coat in winter. Some of the weasels in this State become white in winter and some do not. However, I am unable to see any other differences between them and until more is known concerning this change of coat, it can not be regarded as a sufficient basis for distinguishing a subspecies. I am unable to say just what

per cent. of the weasels of the State change color in winter. Brown winter specimens are apparently found throughout the State. I have records of white individuals from Monroe, Miami and Knox counties and the Kankakee valley.

The New York weasel is the only species recorded from the State, and its range, at the present time, seems to include every county.

Habits.—Weasels are the most bloodthirsty of all our mammals. Like the mink, they will invade a chicken-house and kill a large number in a single night. They are also good mousers and sometimes do good by entering barns and destroying the mice and rats there. Field mice and wood mice are also killed in large numbers, but the good they do in this way is counterbalanced by the birds they destroy. They are better climbers than either the skunk or mink, hence do much more damage among the songbirds. Grouse and quail are also numbered among their victims, and it is said that a hundred quail may sometimes be destroyed in a single night.

Nor do they stop with the smaller animals. Woodchucks and muskrats are doubtless killed in their homes, while rabbits form one of their staple articles of food. I have often seen tracks in the snow where weasels had been following a rabbit. Rhoads tells of a hunter following the track of a weasel in the snow and finding eleven dead rabbits which the bloodthirsty little animal had killed in a single night. They were either hidden in the hole that they had started from, or pulled under the snow, sometimes 20 feet or more to some brush pile. They are killed by biting between the eye and the ear, the wound being so small that it is difficult to find. The hunter who gave this account had spent much time hunting and trapping weasels. He declared that they never rest, but are always killing. With the snow eight inches deep and the mercury 7 degrees below zero, he was unable to catch up with one he was tracking.

Because of their small size they can enter the burrows of ground-squirrels and rats, as well as those of the larger rodents, and no inhabitant of the woods, excepting the larger carnivores, are safe from their depredations. They are not at all averse to coming near dwelling houses, either at night or during the day. I have known in a number of instances, of persons seeing them about a barn or garden during daylight.

Because they are such good travelers, it is not easy to find their dens and set traps for them, even when their tracks are found in the fresh snow. They wind in and out among the trees, entering

the base of a hollow tree here, a hollow log there, next a deserted woodchuck hole and then a natural cavern. But they almost always emerge at the same or another entrance and go on. Indeed they probably have no permanent homes except at the breeding season, but hunt till tired and satiated, then enter some convenient shelter for sleep, only to emerge and go on to another den miles away.

The young are said to number five or six to the litter and are born in April or May. The nest is sometimes placed in an extensive, labyrinthian burrow which the animals are supposed to make for themselves. More often, however, it is placed in a rock-pile or behind the wall of a bridge, where the wagons rumble by unheeded. Hollow logs, natural caverns or holes which other animals have made and deserted, or from which they have been ejected by force, are also used as homes by these animals.

Genus MUSTELA Linnaeus.

Mustela Linnaeus, Syst. Nat., ed. 10, Vol. I, p. 45, 1758.

Dental formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{4-4}{4-4}$; M, $\frac{1-1}{2-2}$.

Generic characters.—Size larger than a mink; tail long and thick; ears short; claws partly retractile; toes only, applied to the ground in walking; habits principally arboreal.

This genus includes the martens, sables and fishers and is found in the northern parts of both the eastern and western hemispheres. Only a few species are known. Five forms are recognized from North America. One of these formerly occurred in Indiana and it is possible that another, the pine marten (*Mustela americana*) once lived in the State, although we have no evidence of it.

MUSTELA PENNANTI Erxleben.

FISHER; PENNANT'S MARTEN; PEKAN.

[*Mustela*] *pennanti* Erxleben, Systema Regni Animal, Vol. I, p. 470, 1777.

Description.—Larger than the mink, with a longer, more bushy tail and a fox-like head. Legs, tip of tail and belly nearly black, with light spots on throat or under part of body; back dark brown or blackish posteriorly, the head and shoulders being lighter brown and generally grizzled with hoary tipped hairs.

The skull is very much larger than that of the mink and longer in proportion to its breadth; the zygomatic arches do not flare out

so much, but the skull narrows abruptly in front of them; the audital bullae are more rounded and prominent.

Measurements.—Miller gives the following: Total length, 890 mm. (35 in.); tail, 355 mm. (4 in.); hind foot, 120 mm. (4¾ in.).

Range.—The fisher is an animal of the northern forests and is generally supposed to be limited to Canada, the extreme northern edge of the United States, and the Alleghany Mountains. I am compelled to include it in the list of mammals from this State on account of two records. The first is by Wied, who mentions it as "*Mustela canadensis* Linn. Gmelin, Der Pekan Marder." *Mustela canadensis* is a synonym of *M. pennanti*, often used by the earlier naturalists, and the vernacular name "Pekan" is also used exclusively for this species. Wied says that he did not see the animal in the flesh, but that it had been sometimes taken at New Harmony. The other record is that of Dr. Plummer, who includes it in his list of mammals of Richmond with the statement that it had not been seen since 1820.

Habits.—I am unable to say how this animal got the name "fisher" for, according to all accounts, it does not enter the water to fish. Its food is principally rabbits, especially the large snowshoe hares of the northern woods. Fishers are said to be able to kill porcupines, of whose flesh they are especially fond. Birds are eaten and also any sort of small mammals up to the size of the raccoon.

These animals are perfectly at home in the trees and can travel in their tops, springing from branch to branch with even greater agility than a squirrel. They are among the wildest and shyest of all our mammals, and do not remain in a region where settlements have become numerous.

Family PROCYONIDAE.

RACCOONS.

Like the bears, members of this family rest the sole of the entire foot, from the heel down, on the ground when standing. The claws are moderately long and not retractile as they are in the cats. There are five toes on each foot. The tail is generally ringed with black and white. In our species the teeth are 40 in number.

Most of the species are found in temperate and tropical America, but there is one genus in the old world. The North American genera number six and the species 18 or 20. A single genus is found in the eastern United States.

Genus PROCYON Storr.

Procyon Storr, Prod. Meth. Mamm., p. 35, 1780.

Dental formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{4-4}{4-4}$; M, $\frac{2-2}{2-2} = 40$.

Generic characters.—Body stout; head broad behind, but with a pointed nose; legs and tail rather short, the latter cylindrical and ringed with black and yellowish white; color always more or less black (never red or brown).

The genus has a range extending from Brazil to about 60 degrees north latitude in Canada. About ten forms occur in North America and an unknown number in South America. A single species is found in the eastern United States north of the Gulf States.

PROCYON LOTOR (Linnaeus).

RACCOON.

[*Ursus*] *lotor* Linnaeus, Syst. Nat., ed. 10, I, p. 48, 1758.

Procyon lotor Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 136, 1894.

Diagnostic characters.—Distiguished from other mammals of the eastern United States by the ringed tail and pointed nose.

Description.—General color yellowish gray, with many hairs tipped with black; the soft under fur dusky. Face yellowish white with broad black streaks extending across the cheeks and including the eyes, but with a yellowish spot enclosed by the black just above the eyes; naked tip of nose also black. Ears yellowish, except at the bases which are dusky; dorsal surface of feet yellowish; soles of feet naked and dull black. Tail ringed with black and yellowish, the black forming the tip.

The above description is based on a male, scarcely mature, from Mitchell. The color varies considerably and sometimes specimens are nearly white while others are coal black, with perhaps faint traces of a lighter color.

Measurements.—I have no measurements of Indiana specimens that are near the maximum size; the one from Mitchell, mentioned above, was only a trifle over 25 inches long. Miller gives the following measurements: Total length 830 mm. (33 in.); tail, 250 mm. (10 in.); hind foot, 120 mm. (4¾ in.).

Skull and teeth.—The skull is rather high but smoothly rounded on the dorsal surface. The palate is broad and the skull does not taper as much as the pointed external form of the head might lead one to suppose. Teeth heavy; canines proportionally smaller than in the dogs and cats.

Range.—The common raccoon is found in wooded regions from the Atlantic to the Rocky Mountains and from Florida and Texas to the northern boundary of Athabasca, about 60 degrees north latitude. They do not usually live far away from timber, and hence their numbers are diminishing with the forest.

They were very numerous in the great woods of southern Indiana in the early days and were also found in the timbered swamps to the north, but were not abundant on the prairies. At the present time I do not think they have been completely exterminated in any county in the State, but they are not abundant in thickly settled counties like Marion or in the prairie regions like Benton County.

Habits.—The raccoons combine aquatic and arboreal habits to a greater extent than any other species of mammal that I know. The home was always in a tree in former times, although Mr. E. B. Williamson tells me they now live in tile ditches in Wells County. The name *lotor*, meaning one who washes, was bestowed because of their habits of washing meat in a stream before eating it. I am not at all sure that this is an invariable custom, but it is often done and the animals are fond of playing in the water. One that I once had as a pet liked nothing better than a dish of water in which he dabbled with his feet, sometimes washing his nose and lips also, but generally watching something else and paying little attention to the water as long as he could keep his feet in it.

The food is obtained in part from the water. The animal can swim about as well as he can do anything else; he is extremely clumsy in all his movements. But he usually watches at the water's edge for fish and crayfish instead of trying to catch them in deep water. Pond snails and fresh water mussels are also eaten.

Besides aquatic animals, raccoons eat young birds, birds' eggs, poultry, probably some mice and young squirrels, blackberries, apples and other fruit, corn in the milk and, more rarely, mature corn in the shock, acorns and nuts. Honey is also taken from stores of the wild bees. It is therefore apparent that the animals are not strictly carnivorous, but are omnivorous.

No doubt the omnivorous diet has been useful in enabling the animal to hold its own fairly well under great odds. For the raccoon is a clumsy, slow moving animal, unskilled either in defense or flight. His most dangerous trait is his curiosity. It leads him to run along every fallen log and cross every foot bridge and thus enables the trapper to set his traps where the animal will be likely to get into them. Curiosity also leads him to tamper with the trig-

ger of a steel trap placed in water and covered with bright tin foil. In this way the 'coons are often caught without bait.

There is a peculiar charm about 'coon hunting where the animals are numerous enough to make it reasonably certain that the dogs will tree one. A good 'coon dog is the first requisite, for dogs that will trail a fox or a rabbit will not always tree a 'coon. When a warm trail is struck it is seldom long before the animal is treed and the dogs gather around the tree, making the woods reverberate with their bellow. A lantern with a good reflector is the next thing needed, to "shine the 'coon" as the process is called. When the hunters come up, the light from the lantern is thrown up among the branches and if the 'coon is there, his greenish yellow eyes can usually be seen, glaring down from high in the top, and the hunter uses them as a mark at which to aim. In the days of good marksmen, the use of any weapon but a rifle was scorned. At the present day the choke-bored shot gun is more often used and it will generally carry high enough to bring down the animal from any tree left standing in our forests.

It was stated above that the animals are poorly adapted for either flight or fight, but they can fight desperately when brought to bay. I once saw an old female, standing in a shallow pool of water with her back to an overhanging bank, keep four husky dogs at bay for ten or fifteen minutes. She was finally captured alive by slipping a noose over her head from the bank above and swinging her up into a box.

A hollow stub of an oak had been cut to drive her out. Besides the adult, five young, weighing perhaps eight or ten ounces each, were found in the nest of leaves inside the stub. They were all taken alive and kept for some weeks. They showed very great differences of disposition and only one became really tame. He remained a pet until late summer, when he escaped. Two or three days later he came back and began paddling in his dish, which was his way of asking for food. He was chained up and remained until October, when he again escaped and was not seen afterward.

He would eat anything the cats would eat and was fond of milk, but he resented any interference when eating and was always less tractable with strangers than with those he knew. Besides his ordinary food, he once caught a salamander and ate it, and another time a garter snake. However, the delicacy he most esteemed was crayfish, and it was always difficult to persuade him to leave when he was taken to the creek to catch them. This he did with his hands with-

out being pinched by their chelæ, but I am unable now to say just how the feat was accomplished. He showed a disposition to attack poultry, but was never given an opportunity to do so.

Raccoons are near relatives of the bears and resemble them in many habits. Their fingers are long and flexible and the thumb is somewhat separated from the other digits, although not opposable to them. Hence they possess considerable agility with their hands and use them to pick up and hold food. They can also rear up on their hind feet and move about quite actively in this position.

Family URSIDAE.

BEARS.

Animals of large size, with rudimentary tail and plantigrade toes, five on both fore and hind feet; claws not retractile; teeth in American species, 42.

Bears are found in all of the continents except Australia. Four or five genera are now recognized, most of which contain only a few species. Two genera are represented in North America. The one contains only the polar bear and the other is divisible into three subgenera of which the Kadiak, grizzly and black bears are the American representatives. Only one genus is found in the eastern United States.

Genus URSUS Linnaeus.

Ursus Linnaeus, Syst. Nat., ed. 10, Vol. I, p. 47, 1758.

Dental formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{4-4}{4-4}$; M, $\frac{2-2}{3-3} = 42$.

Generic characters.—Color never white; head short and broad with very heavy jaw teeth. There is no danger of confusing the genus with any other in North America.

The genus occurs in the northern half of both eastern and western hemispheres and also has representatives in South America. Sixteen or 18 species are found in North America. Only one species is found in the northeastern part of the United States.

URSUS AMERICANUS Pallas.

BLACK BEAR.

Ursus americanus Pallas, Spicilegia zoologica, fasc. 14, p. 5, 1780.

Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 136, 1894.

Diagnostic characters.—Front claws not longer than hind ones; color black or dark brown.

Description.—Body covered with a coat of long, loose hair, which varies in color from cinnamon brown to dark chestnut and coal black. The forward part of the face is generally brownish. The ears are rather short, densly furred and rounded. The body is highest just in front of the hips, rounding off in the one direction to the mere rudiment of a tail, and in the other sloping to the rather low shoulders and still lower head. The legs seem to be unusually loose from the body and give one the impression of props, hinged to the dorsal part of the body, instead of a component part of it, as they appear in most mammals. The low-carried head, which can be raised to the level of the top of the back only when the animal rears itself on its hind legs, is also peculiar. Add to this the shuffling, swinging gait and you have an animal so grotesque that it is not difficult to see why it is so often caricatured by comic supplements and "Teddy Bears."

Measurements.—I have no definite measurements of the species; the total length is about five feet.

Skull and teeth.—No other mammal in this region has a skull so powerful and compact, although those of the elk and bison exceed it in length. The skull varies considerably and the older animals have a sagittal crest which is not found in the young adults. The males have larger skulls than the females. Baird gives the length of a New York skull as 10.7 inches; greatest width, 7.6.

The molar teeth have broad, flattened crowns, with folds and tubercles of enamel, and present a very compact appearance, markedly different from that of the ungulates. The canines are thick and powerful but not long.

Range.—The black bear formerly inhabited all of the region from Mexico and the gulf states to the limit of trees in Canada. At one time the black bear was fairly common in all parts of Indiana, although the species was never as abundant as wolves, deer and most of the smaller animals. It survived some decades after the elk, beaver and bison had disappeared.

The Prince of Wied states that bears were already becoming scarce along the Wabash near New Harmony in 1832-33. One was killed that winter near Mount Vernon on the Ohio. Robert S. White writes me that the last bear was killed in Warrick County in 1842. Mr. Chansler says of the region near Vincennes: "Bears were quite common in the early days." Dates given are 1830, 1834, 1845; one in Washington County in 1839; one killed near Bee Hunter Marsh, Knox County, in 1860 by Mr. Walker; in Black Creek Marsh, Greene County, one was killed in 1870, and another in 1875.

The Vincennes Commercial reported two young killed near Montour's Pond, Knox County, in 1882. Mr. Chansler thinks these must have been strays, and that the species was extinct there at an earlier date.

In Franklin County, according to Dr. Haymond, the last one was taken about 1840. Dr. Plummer says that the last one was killed in the immediate vicinity of Richmond in 1824. Mr. George Leak of Lizton states that a Mr. Osborn killed a bear in Hendricks County in the early forties.

The historian of Lagrange County says, "occasionally still a bear strays into the county and raises a commotion." This history was published in 1882 but probably written a year or two earlier. Evermann and Butler, on the authority of Steininger, give 1878 as the last date for that county. Mr. Upson, who is well informed on the natural history of this county, gives 1853 as the latest record. A cub was killed in the fall of that year by Hon. S. P. Williams.

In Noble County Prof. Van Gorder says bears were never common and none have been seen since 1846. However, Weston A. Goodspeed says in his history of the county (p. 164) that the forest fires in Michigan in 1860 "drove many bears and other wild animals down into Indiana and Ohio. A large black bear came to Mr. Bourie's residence and was first seen by Mrs. Bourie, who thought it was a large black sheep. When it jumped over a fence she realized its true identity. Mr. Bourie and others started in pursuit but it made for the river and finally escaped."

In the history of Allen County, edited by T. B. Helm and published in 1880, he says (p. 154): "A large marsh known as Bear's Nest covers the northern part of the township [Jackson]. Exterminated elsewhere, this spot was left as their peculiar possession. As recently as four years ago bears were seen and killed in this swamp." The history of Lake County by Goodspeed states that a bear was killed in that county in 1850. Mr. Sims says they did not live in Clinton County subsequent to 1836, although tracks were seen where one went across the county.

In the hilly region of Morgan, Monroe and Brown counties bears seem to have been very numerous up till about 1836. There are a number of instances of bears being killed mentioned in the history of Monroe County, but the latest date positively mentioned is 1829 or 1830. In 1819 a track was found in the light snow and followed to a point near Elletsville, where it was found that the animal had entered a large sycamore tree. The tree was cut and a large female and two cubs, three-fourths grown, were found inside

and killed. In Brown County, bears are recorded as late as 1836 and doubtless were found later. M. W. Gregory states that he and three other persons still living partook of the meat of a bear killed near Martinsville in 1837, after a long chase, during which the bear crossed White River seven times.

Habits.—Although the bears belong to the order of carnivorous animals, they do not restrict themselves to a flesh diet. During the summer they live principally on berries and other fruits, together with roots and tender plants, supplementing this vegetable matter with insects, fish, mice, frogs and a great variety of other matter. A number of correspondents tell stories of bears carrying away hogs. They usually give no dates, but I suspect this usually occurs in the spring when the animals have but recently come forth from the winter's fast.

In their search for insects and other smaller animals, the bears use their powerful feet and long claws, tearing up stumps and old logs and overturning rocks with ease. They are also experts at fishing and in the rivers of the Northwest, where the salmon run, they live exclusively on these fish at certain seasons and become very fat.

As a rule, bears are not dangerous to human life and they can generally be frightened away. Dr. U. H. Farr, of Paragon, relates two adventures which his mother had with a bear in Morgan County in the period about 1830. On one occasion she and her sister were hauling maple sap from trees to a camp, with an old mare hitched to a sled. The horse became frightened and on looking for the cause the girls espied a large bear coming into the clearing. They both climbed on the horse and, lashing her into a run, made for camp, tearing the sled to pieces on the stumps and hummocks. Their father started in pursuit of the bear which was killed next day. On another occasion, the same girl was crossing a bayou on a log foot-bridge some distance from any habitation; chancing to hear a noise, she looked down the creek just in time to see a large bear rearing up on some logs to look at her from the distance of a few rods. She was much frightened but began to clap here hands and halloo. At first the bear paid no attention but at the third shout he turned around and started slowly away.

Dr. S. C. Richardson also relates several incidents which came within his personal knowledge when a boy in southern Indiana; his experiences reach back to 1828. On one occasion when returning home with his mother at dusk, they came upon a full-grown bear in a path in the woods. Mrs. Richardson was a strong, courageous

woman, and began to shout and beat on some saplings with a club and the bear slowly got out of the path, allowing them to make their escape. A few days later, near the same place, two brothers and a sister saw a bear lying high up in the forks of a tree.

Not long after the events recounted above, a girl named Matilda Blakely, in the same neighborhood, while washing clothes beside a creek, was attacked by a bear which got his paws about the girl's throat and injured her so badly that she was confined to bed for a number of weeks. This bear, which was an old female, was killed by the men who rushed to the girl's rescue on hearing her screams, and three cubs were captured.

In spite of their awkward appearance and clumsy movements, bears are very active animals. They are very shy in regions where they have been hunted, and are often treed by dogs, for they can climb a tree with great agility. Mr. Rhoads says they will drop 20 or 30 feet from the branches of a tree when discovered by a hunter, and make off unhurt. They can slip away through a dense thicket and make scarcely any noise.

It is well known that bears hibernate during the winter. However, they do not go into winter quarters until November or December, and now and then venture out even in mid-winter. As far as I can learn, they do not suspend breathing; certainly the heart does not stop, during the hibernating period.

The mating season is just before they begin to hibernate. The young are born about forty days later, that is, in January or February. The female remains in her den for some weeks longer. From one to five cubs are produced in a litter, two or three being the most frequent.

With the possible exception of the opossum, no mammal is so small when born, in proportion to its adult size. The naked and blind cubs weigh only from 9 to 12 ounces when born. The adults sometimes reach a weight of about 300 pounds, but probably do not average more than 250 pounds. The increase in weight is, therefore, from 300 to 650 per cent.

The females breed but once in two or three years. The slow rate of increase is compensated for, in part, by the immunity from danger which adult bears have in their native haunts, and in part by the care which the mother bestows on her offspring. They usually remain with her for two years, sometimes hibernating with her the second winter. When they do this the mother probably does not breed again until the third year.

The she-bear will fight for her cubs with great ferocity. Bears

will also fight when wounded or when brought to bay. They use their paws to strike with, but also bite when they get into close quarters. Their well-known habit of hugging is used chiefly in carrying off live animals, as hogs.

Order INSECTIVORA.

MOLES, SHREWS AND THEIR RELATIVES.

This order comprises a number of mammals of small and medium size. They differ from the rodents in always having two or more incisors on each side of the upper and lower jaws; in the presence of canines, and the sharp, triangular cusps of the molars. The muzzle is usually narrow and pointed and most members of the order live in burrows, although a few oriental species climb trees. In the American species there are no external ears, the eyes are rudimentary and the fur is very dense and soft. Two families are represented in North America, the moles (*Talpidae*) and shrews (*Soricidae*). The broad fore foot of moles is the most obvious character which distinguishes them from the shrews.

Family SORICIDAE.

SHREWS.

This family contains a large number of species and genera and is distributed throughout the northern hemisphere. The members of the family are all small animals that live chiefly under ground. Their food consists principally of insects and worms which are perceived by the sense of smell. Hearing is also acute, but vision is poor or lacking.

The American species all belong to the subfamily *Soricinae* which is characterized by red pigment on the crown of the teeth. None of the American species exceed five inches in length.

Genus BLARINA Gray.

Blarina Gray, Proc. Zool. Soc. London for 1837, p. 124, 1838.

Dental formula.—I, $\frac{3-3 \text{ or } 4-4}{2-2}$; C, $\frac{1-1}{0-0}$; Pm, $\frac{2-2}{1-1}$; M, $\frac{3-3}{3-3} = 30$ or 32.

Generic characters.—Ears small and hidden by the fur; eyes also small and rudimentary; fore feet slender as in the mice, not broad like a mole's; tail shorter than the body without the head; nose pointed.

This genus is limited to America, a single species being known

from South America, and more than twenty from North America. Three forms occur in Indiana. They may be distinguished by the following key:

Teeth 30; body slender; tail longer than head. (Subgenus *Cryptotis.*)
parva, p. 602.

Teeth 32; body thickset; tail about the length of the head. (Subgenus *Blarina.*)

Hairs of back tipped with brown; average length about 4⅛ inches.
carolinensis, p. 601.

Hairs of back all blackish or slate; length about 4½ inches or longer.
brevicauda, p. 598.

BLARINA BREVICAUDA (Say).

SHORT-TAILED SHREW; LARGE SHREW; MOLE SHREW.
Sometimes called Mole Mouse.

Sorex brevicaudus Say, Long's Expedition to the Rocky Mts., Vol. I, p. 164, 1823.

Blarina brevicauda Baird, Mammals of N. America, p. 42, 1857. Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 132, 1894.

Merriam, N. Amer. Fauna No. 10, p. 10, 1895.

Diagnostic characters.—Form thickset; tail and legs short; fore and hind feet slender; color glossy plumbeous black; fur thick and soft like a mole's; length of head and body a little less than four inches.

Description.—The typical form of this species is the largest of our North American shrews. The color is sooty plumbeous above and but very slightly paler below. The back shows little or no trace of the brownish color which is characteristic of the southern subspecies, *carolinensis.* Feet, pale flesh color, covered with short whitish hairs; soles and inner side of hind feet plumbeous.

Measurements.—Ten specimens collected in Newton, Porter, Lagrange and Noble counties had the following average measurements: Total length, 115.3 mm. (4 11/16 in.); tail, 23.7 mm. (15/16 in.); hind foot, 15.5 mm. (11/16 in.). Merriam states that specimens from the type locality, Blair, Nebraska, are larger, measuring 127 mm. in total length; tail, 26.5 and hind foot 16.5.

Skull and teeth.—The skull (Fig. 16) is very large and strong for a shrew. Three from Winona Lake have an average length of 23½ millimeters and the greatest breadth is 13 mm. The skull of this species, like those of its near relatives, is triangular both in cross section and in longitudinal outline. The base is flat; audital bullae wholly on the under side of the braincase; palate arched

upward in the middle. The middle upper incisor teeth are large, with a strong downward process and large posterior keel. The other incisors, and also the canines, are small and confusion sometimes arises from the fact that the incisors are supposed to be two above and two below.

Range.—In Indiana the typical subspecies is found throughout the state, except in the southwestern portion, where it is replaced by

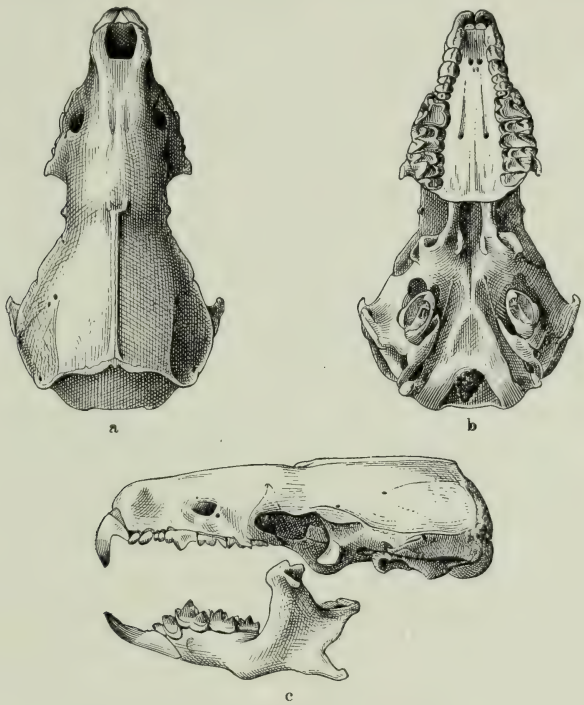


FIG. 16.—Skull of *Blarina brevicauda*, enlarged: a, dorsal view; b, ventral view; c, lateral view. After Merriam, N. Am. Fauna No. 10, Bureau of the Biol. Sur., U. S. Dept. of Agri.

the subspecies *carolinensis*. Probably one form or the other occurs in every township in the State. The range of a species, as a whole, extends from Missouri to Manitoba and east to the Atlantic.

Habits.—One of the best accounts of the habits of this species was published by Dr. John T. Plummer, of Richmond, Indiana, as early as 1844.* His observations were made on captive animals. The following are the most important points in his observations: One specimen was an adept in catching flies. It was fed some

* Amer. Journ. Sci. and Arts, Vol. 46, pp. 245-249.

cooked meat and died soon afterward, but whether from the effects of eating the meat he did not know.

Another was kept in a glass vessel about five inches deep. It moved a cover weighing one pound and escaped from the enclosure during the night. It was retaken next morning and put in a box with some decayed wood and soon made for itself a nest by building up a very compact wall of the rotten bits of wood, afterward lining its home with paper and rags which it cut into very fine bits.

It became very tame and would eat corn, insects or worms from Dr. Plummer's hand, sometimes tugging and pulling at a worm that was held between the finger and thumb. Fresh fish and meat were also eaten, as well as various grains. Excess of food was stored away for future use, but living or fresh food was preferred to that which was stale or putrid.

It learned to come at call and never failed to respond. It would usually come out of its box on hearing the buzzing of a fly, but on warm summer noons generally retired to its box and either did not hear or did not respond to this sound. Except when called out into the middle of the room, it always stayed close to the wall or crept about under furniture.

A full grown mouse placed in the box crept away into the shrew's runways. It soon emerged, however, with the shrew in full pursuit. The mouse exhibited the greatest terror and when it was finally caught, did not offer any resistance and was killed almost instantly. A younger shrew, placed in the box, was also pursued frequently. Finally it gave combat and was killed. The older shrew carried the body away to its nest and then began at once to construct a new nest.

The voice of the shrew is almost exactly like the rapid chip-chip-chip of the ground squirrel. Light and smell do not appear to have an effective range of more than one-half inch from the head of the animal. Hearing is very acute.

In a state of nature, these shrews live in tunnels and runways, which they construct under old logs, in loose soil, the dry leaves of the forest, and dense grass. They are both diurnal and nocturnal. Their food consists chiefly of insects and worms, but seeds and nuts are also eaten. Their natural ferocity is not exaggerated in Dr. Plummer's account of the killing of the mouse. I have known one, in the wild state, to kill a mouse larger than itself.

Prof. E. D. Cope has contributed the following note which further illustrates the ferocity of these animals. "I placed a water snake two feet long in a fernery which was inhabited by a shrew.

The snake was vigorous when placed in the cage in the afternoon and bit at everything within reach. The next morning the glass sides of the prison were streaked with dirt and other marks to the height the snake could reach, bearing witness to his energetic efforts to escape. He was then lying on the earthen floor in an exhausted state, while the *Blarina* was busy tearing out his masseter and temporal muscles. A large part of the flesh was eaten from the tail, and the temporal and masseter muscles and eye of one side were removed. The shrew had apparently not been bitten by the snake.''

In the winter, in some localities at least, they eat large quantities of snails.

Economic status.—It is apparent from the foregoing account that the short-tailed shrew is one of the most useful of our small mammals. The amount of grain or other crops eaten by the species is insignificant, while the good it does by destroying noxious insects and other pests is considerable. The eagerness with which these animals attack mice, indicates that the latter are a regular article of food for the shrews. They sometimes enter cellars and barns and their presence should always be encouraged. They have a disagreeable odor which renders their flesh distasteful to cats and other rapacious beasts and birds.

They are fairly prolific, from two to five young being produced in each litter. The young are born in a nest of grass and leaves, usually placed under an old log. The number of litters per season and other details of their breeding habits are unknown.

The short-tailed shrews appear to be much more abundant in the northern part of the State than in the southern portion, although quite common there also.

BLARINA BREVICAUDA CAROLINENSIS (Bachman).

CAROLINA SHORT-TAILED SHREW.

Sorex carolinensis Bachman, Journ. Acad. Nat. Sci., Phil., Vol. VII, pp. 366-370, 1827.

Blarina carolinensis Baird, Mam. N. Amer., p. 45, 1857.

Blarina brevicauda (part) Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 132, 1894.

Blarina brevicauda carolinensis Merriam, N. Am. Fauna, No. 10, p. 13, 1895.

Diagnostic characters.—Similar to *B. brevicauda* but smaller and more brownish in color. The basal portion of the hair is slate-color in both forms, but in *carolinensis* the tips, instead of having

a leaden gloss, are very distinctly tipped with dark glossy brown. The brown is less distinct on the belly than on the throat and upper surface.

Measurements.—Average of specimens from Monroe, Knox and Lawrence counties: Total length, 102.8 mm. (4⅛ in.); tail, 22.2 mm. (14/16 in.); hind foot, 12.6 mm. (½ in.).

Skull and teeth.—The skull is slightly smaller than typical *brevicauda* but does not differ from it in any essential respect. Skulls from Mitchell average 22 mm. in greatest length and 12 mm. in greatest breadth.

Range.—The Carolina shrew has a range extending from the gulf states north to central Indiana and an east and west distribution from the Atlantic to Arkansas. Indiana localities are: New Harmony, Southern Knox County, Bicknell, Mitchell, Bloomington, Worthington, Terre Haute, Putnam County, Brookville, Switzerland County, Ohio County. Dr. Merriam has recorded a shrew from Richmond as *B. brevicauda* (typical). Of the typical forms I have no others from farther south than Winona Lake. However, the specimens from southern Indiana cannot be regarded as typical *carolinensis,* and there is an intergrading of the two forms throughout the state, but especially in the central portion. The average size of specimens from southern Indiana is less than of those from the northern part of the State, but the differences are not constant and I have relied chiefly on color in separating the two subspecies.

Habits.—What has been said concerning the habits of the northern form of the short-tailed shrew applies with equal force to the southern form. As far as I am aware, their habits are in all respects, similar.

BLARINA PARVA (Say).

SMALL SHREW.

Sorex parvus Say, Long's Expedition to the Rocky Mts., Pt. I, p. 164, 1823.

Sorex cinereus Bachman, Journ. Acad. Nat. Sci., Phil., Vol. 7, p. 373, 1837.

Sorex harlani Duvernoy, Mag. de Zool., 2d Ser., Vol. 4, pp. 37-41, 1842.

Baird, Mam. N. Am., p. 56, 1857.

Blarina exilipes Baird, Mam. N. Amer., p. 51, 1857.

Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 132, 1894.

Blarina cinerea Baird, Mam. N. Am., p. 56, 1857.

Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 123, 1894.

Blarina parva Merriam, N. Am. Fauna, No. 10, p. 17, 1895.

Diagnostic characters.—Size much smaller than the other shrews of the genus (under three inches in total length); tail not over three-fourths of an inch; color brown; eight teeth on each side of the upper jaw.

Description.—The color varies a great deal with the season. The worn summer fur is short and pale, being only a very little darker than the fawn color of Ridgway's plates. The fresh winter pelage is longer and darker; under side ash gray, generally stained with yellowish, especially on the throat and chest; tail dark; upper lip edged with white; feet whitish above, flesh color below, the colors sharply separated. A specimen taken at Mitchell on October 28 has the short summer fur still on the sides and shoulders, while the middle of the back is covered with the glossy brown of the winter coat.

Measurements.—Five specimens from Mitchell averaged: Total length, 72.4 mm. (2 14/16 in.); tail, 16 mm. (10/16 in.); hind foot,

FIG. 17.—Skull of *Blarina parva*: a, dorsal view; b, lateral view. After Merriam, N. Am. Fauna No. 10, Bureau of the Biol. Sur., U. S. Dept. of Agri.

9.8 mm. (6/16 in.). This is slightly less than the average of specimens from the type locality at Blair, Nebraska.

Skull and teeth.—The skull (Fig. 17) is very much smaller than that of the other *Blarinas*. Five skulls from Mitchell average 16 mm. in greatest length and 8 mm. in greatest breadth. The widest portion is midway of the braincase and from this point forward the lateral outlines form a triangle. The braincase is more rounded than in the larger species of the genus. The dentition differs from that of the larger species also, one of the small upper premolars being absent. The skull is remarkably strong for one of its size and is not easily crushed.

Range.—The range of the species is from the Atlantic to Texas and Nebraska and from the Gulf of Mexico northward to Pennsylvania and central Indiana. In this State its range coincides closely with that of *B. b. carolinensis.* Indiana records are: Randolph County, Brookville, Ohio County, Jefferson County, Mitchell, Bicknell, Terre Haute, Putnam County and Irvington.

Habits.—The small size and retiring disposition of this little shrew make it difficult to observe, and but little is known of its habits. I have collected the species often, but have never seen it alive. The specimens I have taken were all found in grassy places, usually where briars and shrubs were mingled with the grass, but never in the woods. Its food consists largely of insects and worms, although it probably eats vegetable food also.

Genus Sorex Linnaeus.

Sorex Linnaeus, Syst. Nat., Ed. 10, Vol. I, p. 53, 1758.
Merriam N. Am. Fauna, No. 10, 1895.

Dental formula.—I, $\frac{4-4}{2-2}$; C, $\frac{1-1}{0-0}$; Pm, $\frac{2-2}{1-1}$; M, $\frac{3-3}{3-3} = 32$.

Generic characters.—Size small, total length scarcely more than four inches in our species; tail half the length of head and body or longer; body slender; eyes rudimentary; snout pointed; feet small and proportioned nearly as in a mouse; colors brownish or slaty.

SOREX PERSONATUS Geoffroy Saint Hilaire.

LONG-TAILED SHREW.

Sorex personatus Saint Hilaire, Mem. du Museum Paris, Vol. 15, p. 122, 1827.

Sorex forsteri Richardson, Zool. Journ., Vol. 3, p. 516, 1828.
Evermann and Butler, Proc. Ind. Acad. Sci., 1893, p. 139.

Sorex cooperi Bachman, Journ. Acad. Nat. Sci., Phil., Vol. 7, p. 388, 1837.

Sorex platyrhinus Baird, Mam. N. Amer., p. 25, 1857.
Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 133, 1894.

Sorex haydeni Baird, Mam. N. Am., p. 29, 1857.

Sorex personatus Merriam, N. Am. Fauna, No. 10, p. 60, 1895.

Diagnostic characters.—Size the smallest of any of our shrews and one of the smallest of all mammals; total length about four inches; tail one and a half inches; form slender and snout pointed.

Description.—Dorsal surface of body brown, brighter on rump

than shoulders. The color fades gradually on the sides to a pale, silvery gray, sometimes tinged with brown on the throat and belly. There is no distinct line of demarcation between the pale color of the under parts and the darker color of the back. Hairs everywhere slaty at the base; tail dark above and light below as the body; feet pale brown. The snout is long and tapering and supports very long whiskers. The tail is about as long as the body without the head.

Measurements.—Average of eight specimens from Ann Arbor, Michigan (taken from Merriam, N. A. Fauna, No. 10): Total length, 95 mm. (3 15/16 in.); tail, 35.3 mm. (1 7/16 in.); hind foot, 11.3 mm. (7/16 in.).

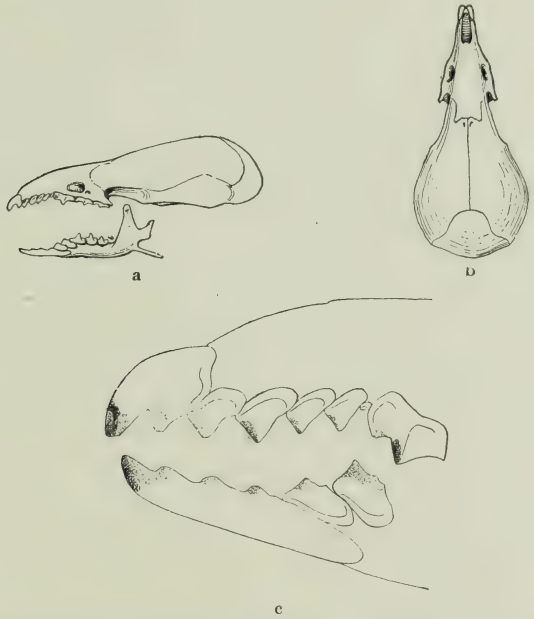


FIG. 18.—Skull and teeth of *Sorex personatus*: a, lateral view of skull; b, dorsal view of skull; c, lateral view of the anterior teeth, greatly enlarged. After Merriam, N. Am. Fauna No. 10, Bureau of the Biol. Sur., U. S. Dept. of Agri.

Skull and teeth.—The skull (fig. 18) is small and slender with a narrow, arched palate and very slender rostrum. Lower incisors ridged or notched except in very old animals with worn teeth.

Range.—From southern Canada to North Carolina and southern Indiana. In Indiana the species appears to be rare, but of general distribution. The only records which can be positively referred to this species are: North Manchester, New Harmony and

Logansport. I have trapped for it unsuccessfully in the sphagnum bogs and marshes of the northern part of the State as well as elsewhere.

Habits.—The long-tailed shrews appear to require more moist situations for their habitat than their short-tailed relatives. Like the latter, however, they most often make their homes under old logs and woodpiles and about hollow trees.

Their food consists chiefly of insects. They are active all winter and their tracks on the snow can sometimes be seen even in the coldest weather, showing where they have traveled about from log to log or stopped to search for food in the decaying wood at the base of a hollow tree.

Dr. Merriam has given us the following account of their habits: "While * * * sitting in the woods a slight rustling sometimes reaches the ear. There is no wind, but the eye rests upon a fallen leaf that seems to move. Presently another stirs and perhaps a third turns completely over. Then something evanescent, like the shadow of an embryonic mouse, appears and vanishes before the retina can catch its perfect image. Anon, the restless phantom flits across the open space, leaving no trace behind. But a charge of fine shot, dropped with quick aim upon the next leaf that moves will usually solve the mystery. The author of the perplexing commotion is found to be a curious sharp nosed creature, no bigger than one's little finger, and weighing hardly more than half a dram. Its ceaseless activity, and the rapidity with which it darts from place to place is truly astonishing, and rarely permits the observer a correct impression of its form. * * *

"Not only are these agile and restless little shrews voracious and almost insatiable, consuming incredible quantities of raw meat and insects with great eagerness, but they are veritable cannibals withal, and will even slay and devour their own kind. I once confined three of them under an ordinary tumbler. Almost immediately they commenced fighting, and in a few minutes one was slaughtered and eaten by the other two. Before night one of these killed and ate its only surviving companion, and its abdomen was greatly distended by the meal. Hence, in less than eight hours one of these tiny wild beasts had attacked, overcome and ravenously consumed two of its own species, each as large and heavy as itself."

SOREX LONGIROSTRIS Bachmann.

SOUTHERN SHREW.

Sorex longirostris Bachman, Jour. Acad. Nat. Sci. Phila., Vol. 7, Part 2, p. 270, Pl. 23, fig. 2. 1837.

Miller, N. Am. Fauna, No. 10, p. 52, 1895.

Merriam, N. Am. Fauna, No. 10, p. 85, 1895.

Amphisorex lesueuri Duvernoy, Magasin de Zoologie, Mamm., p. 33, Pl. 50, 1842.

Evermann and Butler (in part), Proc. Ind. Acad. Sci. for 1893, p. 134.

Diagnostic characters.—Size and color of *Sorex personatus*, but with the rostral portion of the skull much shorter and broader and the fourth upper incisor (third unicuspid) smaller than the third.

Description.—Dorsal surface dark rich brown, becoming paler on the sides; belly smoke gray; tail darker above than below, but the line of demarcation not very distinct; ears rather prominent.

Measurements.—Merriam gives the following as the average of six specimens from Raleigh, North Carolina: Total length, 85.6 mm. (3 7/16 in.); tail, 31.9 mm. (1 5/16 in.); hind foot, 10.7 mm. (7/16 in.).

Skull and teeth.—The specific name *longirostris* is a misnomer, for the rostrum, instead of being long, is unusually short and broad in proportion to the rest of the skull. The skull (fig. 19) is smaller than that of any of our other shrews from eastern North America. The peculiarities of the teeth have already been mentioned and can be best understood by reference to the figures (figs. 18 and 19).

Range.—As far as I am aware, this is the first published record for this shrew for any locality outside of the Carolinas. The species was described by Bachman from the swamps of the Santee river, South Carolina, in 1837. The name was ignored or reduced to synonymy until revived by Miller and Merriam in 1895. In 1842 Duvernoy described *Amphisorex lesueuri* from the Wabash River in Indiana. The identity of this species has never been certainly determined, but the discovery of the southern shrew in this vicinity makes it extremely probable that *lesueuri* is a synonym of *longirostris*.

Only one specimen is known from Indiana at present. It was taken by Mr. E. J. Chansler at Bicknell, Knox County, preserved by him in alcohol and sent to the Biological Survey at Washington. Dr. Merriam identified the specimen as *Sorex personatus*, but when the writer suggested that it might be the species under considera-

tion he kindly had the skull removed and re-examined the specimen and states that it is an old *Sorex longirostris.*

Habits.—Nothing is known concerning the habits peculiar to this species. It is insectivorous, like all of the other shrews, and seems to live both in swamps and on high ground. The rarity of

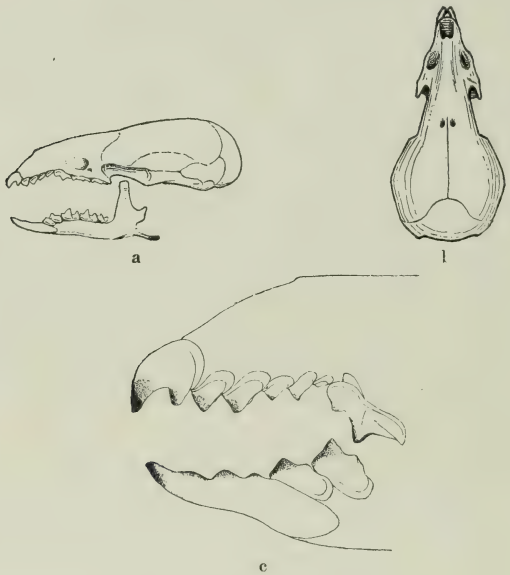


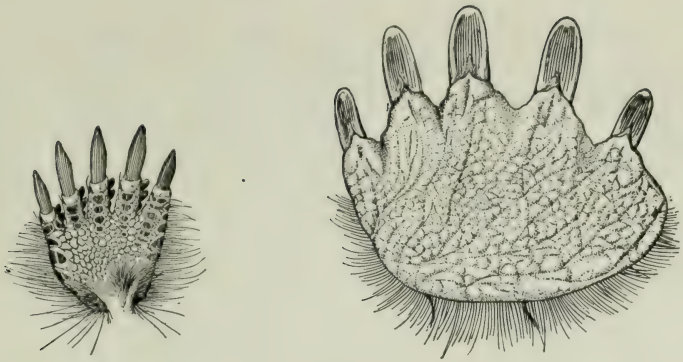
FIG. 19.—Skull and teeth of *Sorex longirostris*: a, lateral view of skull; b, dorsal view of skull; c, lateral view of the anterior teeth, greatly enlarged. After Merriam, N. Am. Fauna No. 10, Bureau of the Biol. Sur., U. S. Dept. of Agri.

this and the preceding species in Indiana add to their interest. The fact that three species were described by Duvernoy from the lower part of the Wabash Valley in this State, and that we are not now positive as to the identity of any of these species, also lends interest and makes it very desirable to secure as many specimens as possible.

Family TALPIDAE.

MOLES.

The moles are distributed throughout most of the northern hemisphere. Most of them exceed the shrews in size, but all resemble them in the form of the head, the character of the fur, the rudimentary eyes and external ears, and the triangular cusps of the molar teeth.

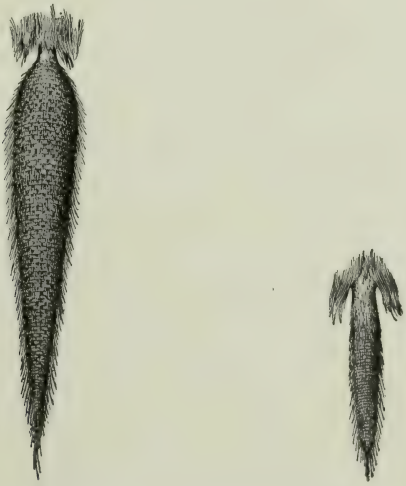


a b

FIG. 20.—Fore feet of moles: a, star-nosed mole, *Condylura cristata*; b, common mole, *Scalops aquaticus*. After True, Proc. U. S. Nat. Museum, Vol. 19.

a b

FIG. 21.—Anterior part of heads of moles seen from below: a, star-nosed mole, *Condylura cristata*; b, common mole, *Scalops aquaticus machrinus*. After True, Proc. U. S. Nat. Museum, Vol. 19.



a b

FIG. 22.—Tails of moles: a, star-nosed mole, *Condylura cristata*; b, common mole, *Scalops aquaticus*. After True, Proc. U. S. Nat. Museum, Vol. 19.

They differ from the shrews in being more perfectly adapted to an underground life. The fore feet (fig. 20) are very broad and the pectoral girdle is powerfully made to enable them to burrow. The pelvic girdle is also strong and the sacral vertebrae are partly fused. The teeth are always entirely white unless stained by food.

Genus Scalops Illiger.

Scalops Illiger, Prodr. syst. mamm. et avium, p. 126, 1811.

Dental formula.—I, $\frac{3-3}{2-2}$; C, $\frac{1-1}{0-0}$; Pm, $\frac{3-3}{3-3}$; M, $\frac{3-3}{3-3} = 36$.

Generic characters.—Nostrils (fig. 21b) on the upper side of the snout, not surrounded by fleshy protuberances; tail (fig. 22a) slender and uniformly tapering from base to tip, not very well covered by the sparse hair; fore feet very broad, elliptical in outline, the longest axis being transverse, and turned edgewise; claws of fore feet long.

This genus is found only in eastern North America, where it is represented by a small number of closely related forms, only one of them being known from Indiana.

SCALOPS AQUATICUS MACHRINUS (Rafinesque).

PRAIRIE MOLE.

Talpa machrina Rafinesque, Atlantic Journ., 1832, p. 61.

Scalops argentatus Audubon and Bachman, Journ. Acad. Nat. Sci., Phil., Vol. 8, p. 292, 1842.

Scalops aquaticus argentatus Coues, Bull. U. S. Geol. Surv. Terr. No. 3, p. 633, 1877.

Scalops aquaticus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 133, 1894.

Scalops aquaticus machrinus True, Proc. U. S. Nat. Museum, Vol. 19, p. 20, 1896.

Diagnostic characters.—Feet very broad, shovel-like; color glossy plumbeous; fur soft and velvety; tail scantily haired, comparatively short, very slightly swollen in the middle. Size the largest of our American moles.

Description.—The subspecies *machrinus* is distinguished from the nearly related forms of *Scalops* chiefly by its large size. Color, glossy hair-brown, below paler with a silvery sheen; bases of the hairs everywhere dark slate color. The fore feet are about half an inch broad, placed vertically with the radial side downward; claws long; stout and flat on the ventral surface; hind feet more slender. Both fore and hind feet are flesh color; nose blackish; the nostrils

completely separated and widely open; tail pale brown or flesh color.

Measurements.—Average of five from Bloomington: Total length, 172 mm. (6 14/16 in.); tail, 29 mm. (1 3/16 in.); hind foot, 26 mm. (1 in.). There is a variation in the series from 157 to 193 millimeters.

Skull and teeth.—The skull (fig. 23) is the largest of any of the moles. It is triangular in outline, with a broad, law, flat braincase,

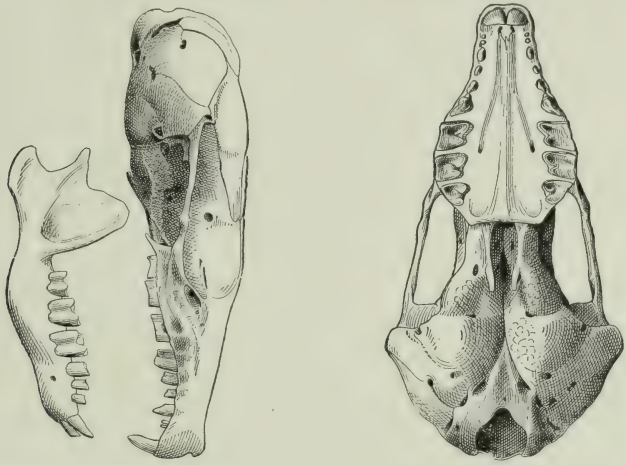


FIG. 23.—Skull of *Scalops aquaticus*: a, lateral view; b, dorsal view. After True, Proc. U. S. Nat. Museum, Vol. 19.

straight, slender zygomatic arches and tapering rostrum. The middle upper incisors are large, but, unlike those of the shrews, they have no posterior heel. The two lateral incisors are very small, as is the first premolar. The canine is about half as long as the middle incisors. Molars with w-shaped crowns. The second lower incisor is large and the lower canine is lacking. Bloomington skulls vary from 36 to 41 mm. in greatest length, with an average of 38.5 mm. and an average breadth of 19.7 mm.

Range.—This form is found throughout the upper Mississippi Valley, closely related races being found to the east and south. In Indiana it apparently occurs throughout the State, although the following localities are the only ones from which there are reliable records: Randolph County, Richmond, Brookville, Ohio County, Madison, Mitchell, Williams, New Harmony, Bloomington, Terre Haute, Carroll County, Boone County, Tippecanoe County, Winona Lake, Vawter Park, Lagrange County.

Habits.—The long ridges of loose earth and occasional heaps or "mole hills" which mark the work of moles are familiar to every farmer boy. However, there are very few people who really know anything about their habits.

Born in a chamber which is hollowed out in compact soil at a depth of eight or ten inches, the young moles are reared in darkness, learn to find food for themselves, take up their domestic duties, live on to old age and die without ever having felt the direct rays of the sun or the breath of a fresh breeze. Their life is one of almost ceaseless activity, and the amount of dirt moved by a mole in a lifetime must be enormous.

Their method of making tunnels has been described a number of times. The long claws of the hind feet are braced firmly in the bottom of the tunnel. The broad fore feet are placed, palms outward, beside the neck and they, together with pointed snout, are thrust forward into the compact soil. The feet are forced backward and outward and the head upward. The soil is, therefore, broken upward, and at the same time a quantity is pushed behind the animal. This is allowed to accumulate until several times the bulk and weight of the animal, when he pushes it back along the burrow and up to the surface to form the familiar mole hill. Where the soil is loose and the animal works near the top, most of the earth is broken upward and little is carried out. In short burrows, made only to catch a worm and not used again, the loose soil is sometimes left, and hence the hills are few in number as compared with the amount of earth actually moved.

Testimony varies as to the exact relation of the mole to the farmer. It is certainly blamed for much damage which it does not do. This is due to the fact that the pine mouse (*Microtus pinetorum scalopsoides* and *M. p. auricularis*) make somewhat similar tunnels and also use those of the moles.

On one occasion I was told that moles were eating the sweet potatoes in a certain garden. I insisted that they were not, because moles never eat sweet potatoes. As proof to the contrary, the mistress of the garden showed me their runways and a number of partially eaten sweet potatoes. I set traps and caught a young pine mouse and later found where a litter of young had been reared under the garden fence. They had done considerable damage to the vegetables and the blame had been laid at the door of the innocent moles, of which there had probably not been one in the garden all summer.

Moles are also blamed for following corn rows and eating the

kernels of sprouting corn. When they do burrow in such places it is in search of cutworms and other insects rather than the corn. Here also the pine mouse is chiefly to blame, although it must be conceded that moles do sometimes uproot the corn by burrowing beneath it.

There is no doubt, however, that moles do damage at times. A beautiful lawn may sometimes be completely ruined by a family which have taken up their residence beneath it and thrust their ugly "mole hills" up through the grass. It is said that they sometimes do damage to strawberry beds by burrowing under the straw with which the latter are covered in winter, and uprooting the plants. Here again I am inclined to think the pine mouse is most often to blame, as it is fond of the roots of a number of plants and usually stays near the surface, while moles are apt to burrow deeper in winter. Both the mice and moles do harm by causing ditches to start where they have tunneled up or down clayey hillsides.

Genus CONDYLURA Illiger.

Condylura Illiger, Prodr. Syst. Mamm. et Avium, p. 125, 1811.

Dental formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{4-4}{4-4}$; M, $\frac{3-3}{3-3} = 44$.

Generic characters.—Nostrils (fig. 21, a) at the tip of the snout, each one surrounded by a fringe of fleshy projections. The tail (fig. 22a) is nearly as long as the body without the head; it is small at the base, but much thickened about half an inch from the body, tapering from that point to the slender tip; it is sparsely haired; fore feet (fig. 20a) broad, but considerably smaller than in *Scalops*.

This genus is confined to eastern North America and contains but one known species. It is readily distinguished by the fringe about the nostrils which is unique among mammals.

CONDYLURA CRISTATA (Linnaeus).

STAR-NOSED MOLE.

Sorex cristatus Linnaeus, Syst. Nat., Ed. 10, p. 53, 1758.

Condylura cristata Desmarest, Journal de physique, Vol. 89, p. 230, 1819.

True, Proc. U. S. Nat. Museum, Vol. 19, p. 78, 1896.

Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 133, 1894.

Diagnostic characters.—Distinguished by the fleshy star about the nose.

Description.—The color is somewhat more brownish above than the common mole; paler and grayer on the under side than the upper. The feet are much smaller than those of the common moles, but are proportionally broader than with most mammals. The tail is also peculiar in that the diameter where it is joined to the body is less than half as great as it is farther away. The eyes are larger than in the other moles, but are much smaller than in most mammals.

Measurements.—Miller gives the following: Total length, 170 mm. (6¾ in.); tail, 72 mm. (2¾ in.); hind foot, 27 mm. (1 1/16 in.).

Skull and teeth.—The teeth number 44, but are much smaller than those of the common mole, the canine being the smallest of

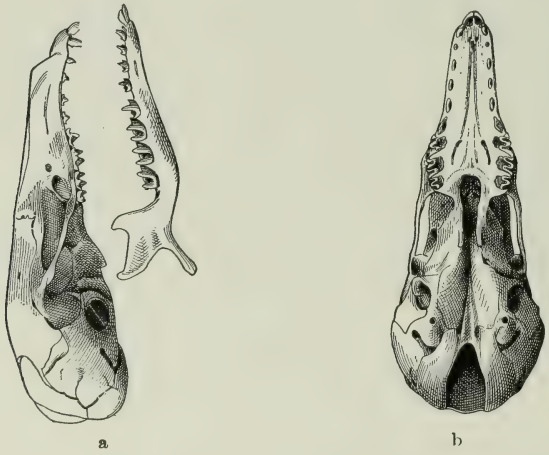


FIG. 24.—Skull of *Condylura cristata*: a, lateral view; b, ventral view. After True, Proc. U. S. Nat. Museum, Vol. 19.

all. The skull (fig. 24) is very long and slender, highest in the middle of the braincase and depressed, anteriorly; palate very narrow; zygomatic arches straight and slender; angular process of the mandible very long and slender as it is in the shrews.

Range.—The star-nosed mole is confined to eastern North America where it is found farther north than any of the other moles; the northern limit is near the shores of James Bay. In the east it is found as far south as Maryland, while Indiana is the southern limit of its range in the west.

In this State it is rare. Prof. Van Gorder has seen but one in Noble County. This one was found in 1886, while some men were

moving a building. The first specimen from the State was taken near Denver, Miami County, in 1887. (Evermann, American Naturalist, Vol. 2, p. 359, 1888.) Mr. C. F. Fite, of Denver, took a specimen near that place on June 3, 1890, and another March 30, 1894. Butler recorded one from Bartholomew County. I am unable to give any other records from the State, although the species has been taken both in Ohio and Illinois.

Habits.—This mole is usually found in damp places and is said to enter the water voluntarily in the pursuit of aquatic insects. It is quite well adapted for aquatic life, and the large fore feet, primarily modified for digging, make good paddles for swimming also. The long tail no doubt serves as a rudder, much after the fashion of a muskrat's tail. The fore feet are much smaller and the shoulder girdle is weaker than in the common mole and this difference is probably a correlation with the difference in habitat; the star-nosed mole lives in softer ground and thus requires less force for digging its tunnels.

The remarkable nasal disk of this species seems to be the seat of tactile organs, of very delicate sensibility. Exactly what habits or conditions of life have brought about their development, we do not know. In the young animal the fingerlike process appear to be little more than ridges on the sides of the snout. The grooves which bound these ridges deepen and grow toward each other till they join and cut off the ridges, leaving them as processes, free from the snout except at their base.

Order CHIROPTERA.

BATS.

The members of this order are easily distinguished from all other mammals by having the fore limb modified into a wing suited for flight. In many respects bats are more highly specialized than any other group of our native animals. The structure of the sexual organs, the highly developed sensory apparatus, the peculiar habits and the adaptation for flight, including the modification of skeleton and muscle, all show that these animals have diverged far from the primitive type of mammals. On the other hand, the power of flight, together with nocturnal activity and the habit of hiding away in hollow trees, caves and other dark places, has reduced the struggle for existence to a minimum. As a result we find an inferior development of the brain and only a small mental capacity.

Family VESPERTILIONIDAE.

TYPICAL BATS.

All of the bats found in the United States belong to this family with the exception of a few species along the Gulf coast and in the southwest. The muzzle is simple without any surrounding folds of skin; the ears are well developed and always have a tragus (fig. 25, t); the bony palate is lacking in the middle line anteriorly;

FIG. 25—Ear of a bat (*Lasiurus borealis*); c, ear conch; t, tragus.

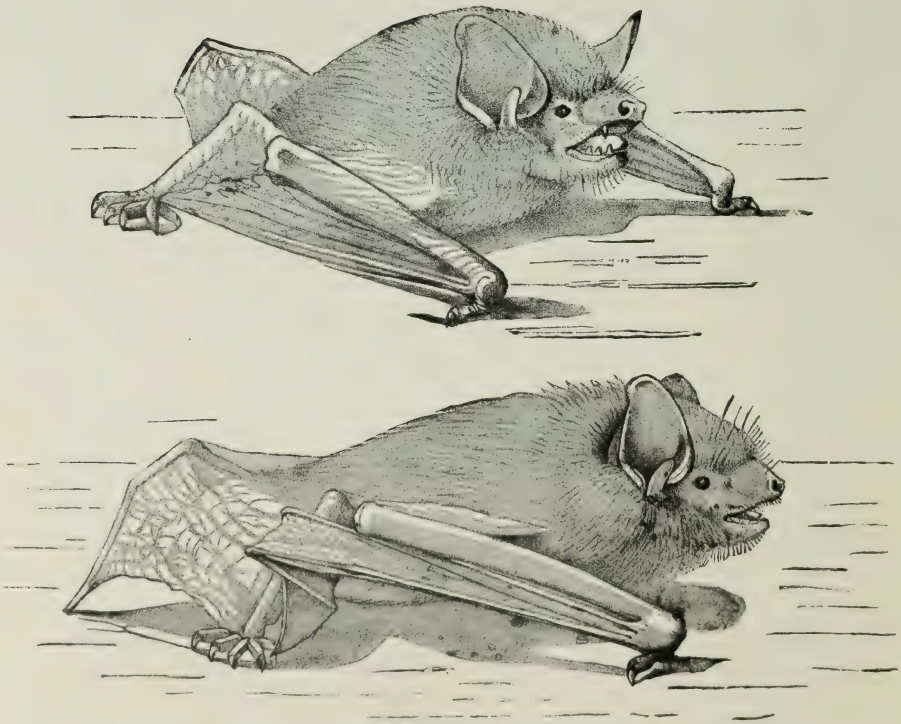


PLATE VII.—The large brown bat (*Eptesicus fuscus*) walking. After Harrison Allen, Bull. No. 43, U. S. Nat. Museum.

the teeth have w-shaped crowns with sharp cusps; the wing is highly specialized, the ulna being reduced to a splint; the interfemoral membrane is complete, reaching nearly or quite to the tip of the long tail.

The family is of world-wide distribution, being absent only from some of the smaller islands and the arctic regions.

Genus Corynorhinus H. Allen.

Dental formula.—I, $\frac{2-2}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{2-2}{3-3}$; M, $\frac{3-3}{3-3} = 36$.

Generic characters.—Ears very long and their bases slightly joined together across the forehead. Tragi long, narrow and pointed. A large glandular protuberance between the eyes and nostrils.

Skull (fig. 26) slender, with a high, rounded braincase and weak rostral portion. The dentition distinguishes this genus from

Fig. 26.—Skull of *Corynorhinus macrotis*. After Miller, N. Am. Fauna No. 13, Bureau of the Biol. Sur., U. S. Dept. of Agri.

any other found in Indiana with the exception of *Lasionycteris,* which, however, has short, broad ears and a flat, elongated skull.

The genus is represented by but one known species, with two subspecies, the entire range being from Central Mexico to the central part of the United States. Only the typical form is found in Indiana.

CORYNORHINUS MACROTIS (Le Conte).

BIG-EARED BAT.

Plecotus macrotis Le Conte, McMurtrie's Cuvier, Animal Kingdom, Vol. 1, Appendix, p. 431.

Corynorhinus macrotis Butler, Proc. Ind. Acad. Sci. for 1894, p. 86, 1895.

Miller, N. Amer. Fauna, No. 13, p. 51, 1897.

Diagnostic characters.—Easily distinguished from all other bats found in Indiana by its enormous ears, which are always more than an inch in length, measured from the crown.

Description.—The color of the back bears considerable resem-

blance to that of *Myotis subulatus*, described farther on. The hairs are dark brown at the base, and the outer third or a little more is golden brown; head and neck more yellowish; belly with the hairs rather darker at the base than those of the back; tips grayish white; throat and sides of breast yellowish, the color shading off gradually into that of the neck and back.

FIG. 27.—Head of *Corynorhinus macrotis* showing glandular protuberance of the nose. After Miller, N. Amer. Fauna No. 13. Bureau of the Biol. Surv., U. S. Dept. of Agri.

There is a thick glandular fold (fig. 27) arising from the muzzle just exterior to each nostril and projecting upward and inward so that the tips of the two touch. The ears are extraordinarily large for the size of the animal, almost equalling the body in length. The basal part of the anterior edges of the two are joined together across the forehead, the basal part, up to the point of union, being much thickened. The anterior edge is convex for its entire length; the posterior edge convex basally, with a slight notch just below the tip. General form of the ear, hastate. The tragus is long and gradually tapering to the narrowly rounded tip.

The membranes are thin and delicate, about the color of the basal part of the fur on the back. Fingers and fore arm the color of the surrounding membranes.

Measurements.—An adult female from Mitchell measured as follows: Total length, 92 mm. (3 11/16 in.); tail, 43 mm. (1 12/16 in.); hind foot, 10 mm. (6/16 in.); forearm, 43 mm. (1 12/16 in.); tibia, 21 mm. (1 1/16 in.).

Skull and teeth.—The skull (Fig. 26) is slender for the size of the bat. The highest point is not at the occiput, but in front of the root of the zygomata. Braincase rounded; base of the skull arched

upward in the zygomatic region. Measurements of the skull of an adult female from Mitchell: Greatest length, 18 mm. (12/16 in.); length of palate, 6.5 mm. (4/16 in.); greatest breadth of braincase, 10 mm. (6/16 in.); depth over bulla, 9.5 mm. (6/16 in.); maxillary tooth row, 6.5 mm. (4/16 in.).

Range.—The southern states north to central Indiana. Until recently the species was not supposed to live north of the Ohio River. Prof. L. M. Underwood took two specimens in a cave near Greencastle, Indiana, in December, 1894, but the record published by Butler in the proceedings of the Indiana Academy for that year seems to have been overlooked. Dr. A. M. Banta took a specimen in Upper Spring Cave at Mitchell in 1902, but this was unfortunately lost. During the winter of 1906-7 the writer saw six individuals in the caves at Mitchell, two of which are now in the collection of Indiana University. In November, 1907, Dr. Charles Zeleny took another individual at the same place. It is apparent, therefore, that the species is firmly established in southern Indiana.

Habits.—I can find no published account of the habits of this species and my own acquaintance with it is not sufficiently extensive to permit a detailed description. Those that I have seen in the cave were all in dim twilight near the entrance. They hung head downward on the side walls of high passages; in one instance two of them were directly over the water. When sleeping in this position the long ears are curved backward and flattened against the sides of the neck. As far as I know this position of the ears is unique among mammals. The curve is edgewise and the upper or anterior edge of the ear forms a half ellipse. The middle of the posterior edge is formed in a number of small transverse folds. When the animals are awakened from sleep, they slowly straighten the ears, and with them erected, they are truly remarkable looking creatures.

Two of these bats which were seen on February 22, 1907, in Upper Spring Cave at Mitchell, escaped and flew out into the cold air, perching for a few moments on the rocky ledge at the mouth of the cave. The fact that all that have been seen in this region were near the mouth of the cave, may indicate that the species is not truly a cave dweller.

The long ears should make it easy to identify in flight if it comes out in the twilight. I have never seen it flying, and judge that it is a later flier. The flight of those that I have had captive, was swift and steady. In captivity, these bats seem to be delicate. Those that I have kept, refused food and soon died.

The special functions of the extraordinarily long ears and the

glandular protuberances of the muzzle of this species are wholly unknown. A careful study of its habits and sensory adaptations, as well as the development and minute structure of these organs, should be well worth while.

Genus Myotis Kaup.

Myotis Kaup, Skizzirte Entw.-gesch. u. Natürl. Syst. d. Europ. Thierw., I, p. 106, 1829.

Dental formula.—I, $\frac{2-2}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{3-3}{3-3}$; M, $\frac{3-3}{3-3} = 38$.

Generic characters.—Size small; ears and tragi (fig. 28, a, b, c) slender and pointed; the latter generally straight. The only char-

Fig. 28.—Ears of bats: a, *Myotis lucifugus* (x 2); b, *Myotis subulatus* (x 2); c, *Myotis velifer* (x 1½); d, *Pipistrellus subflavus* (x 2). After Miller, N. Am. Fauna No. 13, Bureau of the Biol. Sur., U. S. Dept. of Agri.

acter which certainly distinguishes the species of this genus is the presence of six teeth behind the canine on each side of the upper jaw. This character is not possessed by any other bats found in eastern North America.

The genus is widely distributed, being represented by several species in each of the continents. In Indiana it is represented by three species which, to the unpracticed eye, bear a close resemblance to one another.

The following key will serve to distinguish them:

Size large; forearm 42 mm. (1 11/16 in.) or more. *grisescens.*
Size smaller; forearm never over 39 mm. (1 8/16 in.).
  Ear and tragus long, slender and gradually tapering. *subulatus.*
  Ear and tragus broad, the latter bluntly rounded. *lucifugus.*

MYOTIS LUCIFUGUS (Le Conte).

LITTLE BROWN BAT; CAVE BAT.

Myotis lucifugus Le Conte, McMurtrie's Cuvier, Animal Kingdom, Appendix, p. 431, 1831.

Vespertilio gryphus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 134, 1894.

Vespertilio subulatus Blatchley, 21st Ann. Rept. Ind. State Geol., p. 180, 1896.

Myotis lucifugus Miller, N. Am. Fauna, No. 13, p. 59, 1897.

Diagnostic characters.—A medium sized bat (expanse 10 in.), varying in color from glossy wood brown to dull blackish; ears when laid forward, barely reaching the nostrils; tragus short, broad at the base, and blunt (fig. 28, a); the most common bat in southern Indiana.

Description.—It is difficult to formulate a description which will enable anyone not familiar with bats to distinguish this species from the next with certainty. The hairs of the back are always sooty blackish at the base and this is usually concealed by the tips of gloosy wood- or chestnut-brown. Occasionally the tips are also dull sooty or clove brown. The belly is always paler and usually has a yellowish tinge. In *subulatus* the back is apt to have a grayer tinge while the hairs of the under side are usually, but not always, pure white or silvery without the yellow tinge. Membranes and ears dull blackish.

Ears rather short and blunt, broad at the base and suddenly becoming narrower one-third of the distance from the tip; tragus short, wide at the base, blunt and bent forward; membranes thick and naked except a narrow row of fur nearest the body and a few short hairs scattered over the surfaces; interfemoral and wing membranes arising from the base of the toes; calcar slender, with a narrow edge of membrane posterior to it.

Measurements.—Average of ten individuals from Mitchell: Total length, 89.4 mm. (3 9/16 in.); tail, 38.7 mm. (1½ in.); hind foot, 9.9 mm. (⅜ in.); forearm, 37.4 mm. (1½ in.); tibia, 16.6 mm. (⅝ in.); ear, 11 mm. (7/16 in.).

Skull and teeth.—The skull, for a *myotis,* is froad and has a gradually sloping forehead. The face line begins to rise almost from the tip of the muzzle, while in *subulatus* the braincase rises abruptly in the region of the eyes; braincase broader and higher in *lucifugus;* muzzle also broader and the skull, as a whole, appears to be much stronger and heavier; tooth row shorter in *lucifugus;*

first upper premolar much larger than the second; third upper premolar not high in proportion to its width as it is in *subulatus*. Cranial measurements for ten specimens from Mitchell average: Greatest length of skull, 15 mm. (10/16 in.); length of palate, 6.7 mm. (¼ in.); maxillary tooth row, 6.9 mm. (¼ in.); greatest width of braincase, 7.8 mm. (5/16 in.); depth of braincase over audital bulla, 6.9 mm. (¼ in.).

Range.—This species is found from Newfoundland to Kamchatka and south to Florida and Texas. The typical species seems to be absent, however, from the Rocky Mountain region where it is replaced by a slightly different form. In Indiana it occurs throughout the state but is most abundant in the cave region of the southern part.

Habits.—The bats of this species are typically cave dwellers. In winter they collect in the caves of southern Indiana in enormous numbers. Blatchley records taking 401 from one and seven-tenths square feet of the roof of Saltpetre Cave, in Crawford County. In Wyandotte Cave they gather by the thousands and in the many caves, large and small, which I have entered, not one has been without bat inhabitants in winter. During the summer they leave the caves and become scattered over wide areas. Temporary dwellings are found in hollow trees, attics and deserted buildings.

Bats differ from most of the higher animals in that they never construct or occupy any sort of nest or den. Any cranny where the light is not too intense and the temperature is moderate, serves them for a temporary abode. They do not even trouble themselves to return to the same place on successive days.

The young are fairly well developed when born. They cling to the mother's fur and are carried about by her, at least while very young. Some species, and perhaps all, later leave their offspring in some secluded nook and return for them when they have finished feeding. The number of young differs for different species. For *Myotis lucifugus* it is probably one or two. They are born some time in June and grow rapidly, maturing before the end of September.

Mating occurs in November (perhaps in October and December also), but the ova are not fertilized until the bats leave the cave in April. The spermatozoa remain alive in the uterus of the female throughout the winter.

The food of bats consists wholly of insects. So many of these are eaten by each individual and the animals themselves are so numerous that they are almost as beneficial to man as birds. The

feeling of detestation which most people have for them is therefore wholly without warrant. They never become noxious except when, as sometimes happens, they gather in great numbers in the attic of a dwelling. At such times the odor becomes very offensive. They are also infested by many parasites, of which the bedbug is one, and these sometimes overrun a house which the animals inhabit. It is, however, comparatively easy to get rid of them by covering the holes by which they enter with screen wire. The fumes of formaldehyde or bisulphide of carbon will drive them away if the attic is reasonably tight.

There is no reason to believe that bats have decreased in number since the country was first settled. Their nocturnal habits protect them well from man. Birds and beasts of prey cannot get them easily because they hide away in inaccessible places when at rest and their swift, erratic flight makes it difficult for even the owls to catch them, while hawks and other diurnal birds of prey get them only by accident. So greatly has their freedom from danger modified their habits, that the feeling of fear is almost lacking.

MYOTIS SUBULATUS (Say).

THE SAY BAT.

Vespertilio subulatus Say, Long's Exped. to the Rocky Mts., Vol. 2, p. 65 footnote, 1823.

Vespertilio gryphus lucifugus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 134, 1894.

Myotis subulatus Miller, N. Am. Fauna, No. 13, p. 75, 1897.

Diagnostic characters.—Resembles the preceding species in size and often in color; ears longer and more slender, reaching beyond the tip of the nose when laid forward; tragus longer and more pointed (fig. 28, b); skull more slender and with the braincase rising more abruptly from the rostrum.

Description.—Hair dusky at the base; hairs of the back usually smoky brown, seldom tipped with glossy brown; after moulting in late summer, often having a dull golden tinge; hairs of under surface seldom brownish or yellow, generally silvery white. Fur denser and softer than that of *M. lucifugus*. Ears and membranes more grayish than those of the preceding species.

The ears are long and slender, reaching two millimeters or more beyond the nose when laid forward. The posterior border tapers more uniformly than *lucifugus* and the point is less blunt. The tragus is long, slender, nearly straight and uniformly tapering to the narrowly pointed tip.

The membranes are thinner and paler than in *lucifugus,* but in all other respects similar. Calcar longer, more slender and ending indistinctly in the membrane.

Measurements.—Average of ten from Mitchell: Total length, 87.9 mm. (3½ in.); tail, 37.6 mm. (1½ in.); hind foot, 9.9. mm. (6/16 in.); forearm, 37.6 mm. (1½ in.); tibia, 17.4 mm. (11/16 in.); ear, 12.7 mm. (½ in.).

Skull and teeth.—The differences in the skulls of the two species are sufficiently characterized under *M. lucifugus.* Average measurements of ten individuals from Mitchell: Greatest length, 15.3 mm. 10/16 in.); length of palate, 7.3 mm. (5/16 in.); maxillary tooth row, 7.3 mm. (5/16 in.); greatest width of braincase, 7.1 mm. (5/16 in.); depth of braincase over audital bulla, 7.4 mm. (5/16 in.).

Range.—Myotis subulatus is found over practically the whole of North America east of the Rocky Mountains. In Indiana it occurs throughout the State, but is much less abundant than the preceding species. In the caves I have explored, I have found the proportion to be about one of this species to 20 of *M. lucifugus.*

Habits.—The present species, like the preceding one, is a cave inhabiting bat. In most of the published records of this State the common cave bat is erroneously called *Myotis subulatus.* As a matter of fact, the records are for *lucifugus,* while the present species has been entirely overlooked because of its close resemblance to its congener.

The habits of the two species are very similar and the statements made above as to food, breeding habits and relation to man apply, as far as known, with equal force to both. The Say bat begins to return to the caves earlier than the little brown bat, and outnumbered the latter in the Shawnee cave during August, 1907. In captivity the present species appears to be somewhat the more active and intelligent.

The ability of all of the cave inhabiting species to find their way through the tortuous passages of the caves where darkness is absolute, is one of the most remarkable things to be found in the mental makeup of animal. Experiments made by the author show that they do not depend upon sight for guidance. The animals were able to avoid wires stretched in a room, as well when the eyes were covered as when open. Removing the external ears was also without effect. But when the auditory meatus was stopped, their ability to avoid obstacles was greatly diminished. Covering the body hairs

and membranes with a sticky substance, thus rendering them less sensitive, also had a marked effect.

It is probable that the flying bats perceive objects through the medium of the ears when the air between the moving animal and some solid body is condensed. The condensation of the air also stimulates the delicate organs of touch which are located about the base of the hairs on the body and membranes.

Bats have great agility in the air and can alight on a vertical wall or other object which is not perceived until they are within a couple of inches of it. This agility enables them to escape injury by striking head on, against the sides of the cave.

These animals quickly learn to go to a definite location for food or to escape confinement. A *Myotis subulatus* which I had in captivity, readily learned to go to a certain spot in its cage marked by a piece of white cloth. When the cage was turned so that the cloth was on the west side instead of the east as before, the bat still went to the east side instead of to the cloth. This experiment and others like it show that the animals do not depend on sight, hearing, smell or taste for orientation. They have a sense of direction apart from the other senses. This may be truly a sixth sense, located in the muscles and joints or in the semicircular canals; or it may be due to the ability of the animals to quickly render an act automatic, as a blind man learns, after long experience, to go about places with which he is familiar.

MYOTIS GRISESCENS Howell.

GRAY BAT.

Myotis grisescens Howell, Proc. Biol. Soc., Washington, Vol. 22, 1909.

Myotis velifer Miller, N. Am. Fauna, No. 13, p. 56, 1897.
Hahn, Proc. U. S. Nat. Museum, Vol. 35, p. 580, 1908.

Diagnostic characters.—Easily distinguished from any other *Myotis* known to occur in the eastern United States by its large size. The forearm measures 40 mm. (1 2/3 in.) or more.

Description.—The color does not differ markedly from that of other species belonging to this genus. The back is light sepia in color and the belly much paler. In a specimen from Mitchell there are white hairs about the mammæ and along the middle line of the belly, and blackish spots on the shoulders.

The ears (fig. 28, c)[a] are rather short, narrow and pointed, reach-

[a]This figure was inserted when it was supposed that the species under consideration was *M. velifer*. Howell has recently described it as *grisescens*, but the ears are similar in the two species.

ing to or slightly past the level of the nostril when laid forward. The anterior border is very convex except near the tips, where it is slightly concave. Tragus long; the anterior edge straight, the posterior convex for the basal two-thirds, then suddenly tapering to the narrow, rounded tip.

The membranes are very sparsely haired, thick and leathery, and about the color usually found in *M. lucifugus*. Calcar slender and longer than the free border of the interfemoral membrane.

Measurements.—From a single adult female taken at Mitchell: Total length, 97 mm. (4 in.); tail, 40 mm. (1 10/16 in.); hind foot, 10 mm. (6/16 in.); forearm, 44 mm. (1 13/16 in.); ear, 12 mm. (½ in.).

Skull and teeth.—The skull is large and heavily built, resembling *M. lucifugus* in form, but easily distinguished by its larger size. Measurements of one skull from Mitchell: Greatest length, 16 mm. (11/16 in.); length of palate, 8 mm. (5/16 in.); maxillary tooth row, 7 mm. (¼ in.); greatest width of braincase, 8.5 mm. (6/16 in.); depth of braincase over bullae, 7.5 mm. (5/16 in.).

Range.—Known only from Tennessee, Missouri and Indiana. In Indiana but one specimen has been taken. It was an adult female captured in Twin Cave at Mitchell on August 9, 1907. The condition of the mammæ showed that the animal had nursed during that summer. It was sent to Mr. A. H. Howell, of the Biological Survey, who identified it as *Myotis velifer,* and it was so recorded by the writer (loc. cit.). Later Howell mentions this specimen in his description of *M. grisescens* from Nickajack Cave, Tennessee.

Habits.—Nothing is known of the distinctive habits of this species. As far as I am aware, it has never been found far from caves, and it is characteristically a cave dweller.

Genus Lasionycteris Peters.

Dental formula.—I, $\frac{2-2}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{2-2}{3-3}$; M, $\frac{3-3}{3-3} = 36$.

Generic characters.—Ears and tragus short and broad, the former with a large basal lobe; color blackish; interfemoral membrane furred on top on the basal half. The skull (fig. 29) is broad and flat, the rostral portion being very broad in proportion to the size of the skull. The braincase rises gradually from the muzzle and its dorsal profile is nearly straight.

The genus contains but one species which is distributed throughout the United States and southern Canada. Its dental formula differs from that of any other bat found in this State with the ex-

ception of *Corynorhinus*, which, however, has enormous ears, nearly equalling the entire body in length, whereas the ears of *Lasionycteris* are short and barely reach to the nostril when laid forward along the head.

LASIONYCTERIS NOCTIVAGANS (Le Conte).

SILVER-HAIRED BAT.

Vespertilio noctivagans Le Conte, McMurtrie's Cuvier, Animal Kingdom, Vol 1, p. 31, 1831.

Lasionycteris noctivagans Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 134, 1894.

Lasionycteris noctivagans Miller, N. Am. Fauna, No. 13, p. 86, 1897.

Diagnostic characters.—Color blackish, many of the hairs being tipped with silvery white; ears short and broad; interfemoral membrane partly furred.

Description.—The name silver-haired bat may lead the novice to mistake one of the species of *Lasiurus* for the present one. The silver-haired bat is always to be distinguished from those by its dental formula, by the incomplete furring of the interfemoral membrane, and by the fact that the hairs are dark brown or black except for the white tips on some of them, whereas in *Lasiurus* the hairs have a broad light band near the middle. No other bat in this region resembles it in color and in the short ears and tragi.

The ears are short and nearly as broad as long, reaching barely to the nostril when laid forward. The tragus is short and broad; its posterior edge very convex; anterior edge nearly straight; tip rounded. The interfemoral membrane is partly covered with hair on the dorsal side.

Measurements.—Average of ten specimens from Sing Sing, New York (copied from Miller, N. Am. Fauna, No. 13): Total length, 105.8 mm. (4 3/16 in.); tail, 42.4 mm. (1 11/16 in.); hind foot, 7.9 mm. (5/16 in.); forearm, 41.1 mm. (1 11/16 in.); tibia, 17.1 mm. (11/16 in.); ear (from meatus), 15.9 mm. (10/16 in.).

Skull and teeth.—The skull (fig. 29) is rather long and slender, with braincase and palate broad, and the rostrum pinched and narrow. The dorsal outline is nearly straight, the braincase being elevated but little above the face.

Range.—North America as far south as Nebraska and Pennsylvania, and in the mountains to North Carolina. In Indiana I have never encountered it in the southern part of the State. The locali-

ties are Franklin County, Indianapolis, Michigan City. In the northern part of the State it seems to be one of the commonest bats. It has been taken frequently in Chicago and there are several in the collection of the Chicago Academy of Sciences.

Habits.—The writer has never made the personal acquaintance of this bat. It is a tree dweller and is not known to winter in caves. It is known to migrate southward in winter and probably does not stay in the southern half of this State during the summer.

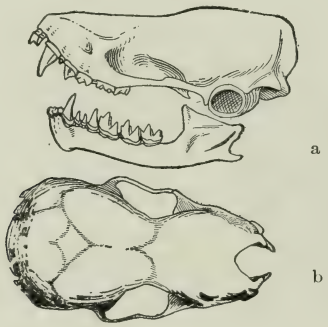


FIG. 29.—Skull of *Lasionycteris noctivagans*: a, lateral view; b, dorsal view. After Miller. N. Am. Fauna No. 13, Bureau of the Biol. Sur., U. S. Dept. of Agri.

Dr. Merriam, in his "Mammals of the Adirondacks," says of it: "Like many other bats it has a decided liking for waterways, coursing up and down streams and rivers, and circling around lakes and ponds. At some places its habit of keeping directly over water is very marked. * * * Several that were wounded and fell into the water at a distance of fifteen or twenty feet from the bank, swam ashore. They swam powerfully and swiftly, for the current was there quite strong and would otherwise have carried them down stream."

Dr. Merriam tells about finding thirteen young in a deserted crow's nest. They were naked and the eyes were closed. The young are generally two in number and are born about the first of July. They commence to fly when three weeks old. The same author gives an account of the finding of an immense colony of these bats in a hollow tree in the edge of Lake Umbagog on June 18, 1880.

Genus Pipistrellus Kaup.

Pipistrellus Kaup, Skizzirte Entwick. Gesch. u. natürl. Syst. d. europ. Thierw., I, p. 98, 1829.

Dental formula.—I, $\frac{2-2}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{2-2}{2-2}$; M, $\frac{3-3}{3-3} = 34$.

Generic characters.—The American species of this genus are small and weak. The ears (fig. 25, d) are proportioned much as in *Myotis*, but the tragus is bent forward at the tip. The Indiana species further differs from any of the *Myotis*, in this region, in that the forearm and fingers are paler in color than the wing membranes about them.

The skull is small and weak, but broad for its size and rounded. The genus can always be distinguished from our other bats by its dentition, the formula being different from that of any other American genus.

The genus is of almost world-wide distribution, though not known from South America. The single species occurring in Indiana is the smallest of our bats and one of the smallest mammals known.

PIPISTRELLUS SUBFLAVUS (F. Cuvier).

GEORGIAN BAT.

Vespertilio subflavus F. Cuvier, Nouv. Ann. Mus. d'Hist. Naturelle, Paris, p. 17, 1832.

Vesperugo carolinensis Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 135, 1894.

Pipistrellus subflavus Miller, N. Am. Fauna, No. 13, p. 90, 1897.

Diagnostic characters.—The smallest bat found east of the Mississippi and the only one having the dental formula given above. Color, light yellowish brown, the hairs being darker at the tips, but these are too short to hide the predominant tint.

Description.—The color is pale golden brown, overlaid on the back by the darker chestnut tips of the hairs. On the under side the general color appears paler because the darker tips are lacking. The hairs are everywhere plumbeous at the base. Ears and membranes blackish, but the forearms and fingers of the living animals are always yellowish brown in contrast to the darker membranes surrounding them.

The ears (fig. 25, d) are of moderate length, reaching to, or slightly beyond the nostril when laid forward. In shape they bear a strong resemblance to *Myotis lucifugus*, but the tip is more bluntly

rounded. Tragus short and broad with the posterior border strongly convex at the base; tip blunt; anterior border straight, but considerably bent forward.

The membranes are thin and delicate, with a few short hairs scattered over their surfaces. The wing membrane is attached at the base of the toes; the interfemoral at the tarsus. Calcar very slender and short; thumb proportionally large.

Measurements.—Average of ten from Mitchell: Total length, 78.4 mm. (3 2/16 in.); tail, 35.3 mm. (1 7/16 in.); hind foot, 8.8 mm. (5/16 in.); forearm, 33.3 mm. (5/16 in.); ear, 9.5 mm.

Skull and teeth.—The skull (fig. 30) is small and light, with a narrow muzzle and very convex braincase; teeth small; the average

a b

FIG. 30.—Skull of *Pipistrellus subflavus*: a, lateral view; b, dorsal view. After Miller, N. Am. Faunt No. 13, Bureau of the Biol. Sur., U. S. Dept. of Agri.

cranial measurements of ten specimens from Mitchell are: Greatest length, 13.4 mm. (½ in.); length of palate, 5.5 mm. (3/16 in.); maxillary tooth row, 5.6 mm. (3/16 in.); greatest width of braincase, 7.2 mm. (5/16 in.); depth of braincase over bulla, 6.4 mm. (¼ in.).

Range.—Eastern United States, from southern New York to Iowa and south to Texas and Alabama. In Indiana it is apt to occur all over the State, but the only records are from the southern half. Next to *Myotis lucifugus*, it is the most abundant bat in the caves of Monroe and Lawrence counties. It has also been recorded from Franklin County. A specimen taken at Mitchell on November 16, 1906, resembles the northeastern form, *Pipistrellus subflavus obscurus* Miller, in its darker and duller coloration.

Habits.—The habits of this species resembles those of the other cave bats. They leave the cave later in the spring and the majority return later in the fall than do the species of *Myotis*.

Mating takes place about the end of November and the young are probably born in July. The single pregnant female which I have examined contained three very small embryos on the 6th of June.

In flight this species is readily distinguished by its small size and the weak fluttering of its wings which makes it resemble a butterfly rather than a bat. The animals are so small and weak that they certainly can not capture and eat large beetles or other large insects. Their food probably consists chiefly of small diptera and moths. The species usually flies high over the open fields when feeding. These bats readily learn to eat fresh meat when in captivity.

The Georgian bat usually clings to the side walls of the higher passages while in the caves. It is less active than the other species of cave bats. Observations in the caves at Mitchell during the winter of 1906-7 showed that *Myotis lucifugus* rarely stayed in one spot more than a week, while *Pipistrellus* often slept in one spot for a month. Hibernation is not uninterrupted in either species, however.

Genus Eptesicus Rafinesque.

Eptesicus Rafinesque, Annals of Nature, p. 2, 1820.

Dental formula.—I, $\frac{2-2}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{1-1}{2-2}$; M, $\frac{3-3}{3-3}$ = 32.

Generic characters.—Size large (in American species); muzzle broad; ears and membranes thick and leathery, the former of moderate length and rather narrow; tragus broad, but pointed. The skull is very large and heavy, broad and flat on top, with a nearly straight dorsal profile; teeth large and strong.

The bright brown color, large size and heavily built body serve to distinguish this genus from any other found in this region. The strong, flat skull and the dental formula also differ from those of any other bat of this region.

This genus has been generally called *Vespertilio* by the more recent writers. Miller* has, however, restricted the latter name to two European species. Under his arrangement, *Eptesicus* contains about 45 species of very general distribution. One species, with five subspecies, is North American.

EPTESICUS FUSCUS (Beauvois).

LARGE BROWN BAT.

Vespertilio fuscus Beauvois, Catalog Peale's Museum, p. 14, 1796.

Adelonycteris fuscus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 134, 1894.

* Families and genera of bats, Bulletin 57 of the U. S. National Museum, p. 208.

Vespertilio fuscus Miller, N. Am. Fauna, No. 13, p. 96, 1897.

Eptesicus fuscus Miller, Bull. 57, U. S. Nat. Mus., p. 208, 1907.

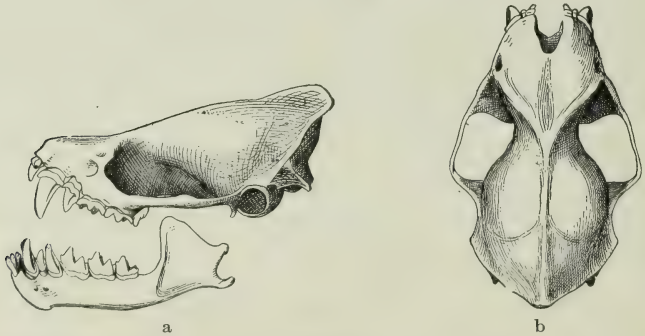
Diagnostic characters.—Size large (four inches or more). Color bright glossy brown; skull very broad, massive and low.

Description.—The color of the back is always a rich glossy brown, although the shade varies considerably. The underside is paler, the belly being sometimes a yellowish gray, oftener light brown; the throat and upper part of the breast usually darker than the belly. The muzzle is covered with short, blackish hairs.

The ears are of moderate length, reaching to the level of the nostrils when laid forward; anterior edge distinctly thickened and the whole ear conch very thick and leathery; anterior edge convex its whole length; posterior concave just below the broadly rounded tip; tragus rather short and blunt at tip. The membranes are thick and blackish. The forearm and fingers are paler on the under side and contrasting strongly with the membrane. Calcar about equal to free edge of interfemoral membrane and, like the limbs, rather strong. Wing membrane arising from the base of the toes; interfemoral from the tarsus.

Measurements.—Adult male from Mitchell: Total length, 107 mm. (4¼ in.); tail, 47 mm. (1 14/16 in.); hind foot, 11 mm. (7/16 in.); forearm, 45 mm. (1 13/16 in.); ear, 11 mm. (7/16 in.).

Skull and teeth.—The skull (fig. 31) is very large and flat; the braincase is somewhat wedge-shaped; the interorbital constriction



a b

FIG. 31.—Skull of *Eptesicus fuscus*: a, lateral view; b, dorsal view. After Miller, N. Am. Fauna No. 13, Bureau of the Biol. Sur., U. S. Dept. of Agri.

is deep; in old individuals there is a prominent median ridge which divides at the interorbital constriction and runs forward as two fronto-maxillary ridges. There is a marked depression on either side of the median line of the rostrum; braincase flat. The jaws

are strong and the teeth large. Cranial measurements of an adult male are as follows: Greatest length of skull, 20 mm. (13/16 in.); length of palate, 9 mm. (6/16 in.); maxillary tooth row, 9 mm. (6/16 in.); greatest width of braincase, 10 mm. (7/16 in.); depth of braincase over bulla, 8 mm. (5/16 in.).

Range.—North America, from Mexico to the colder regions of Canada. In Indiana it doubtless occurs all over the State, although it has been reported only from Vigo, Lawrence and Monroe counties in the southwestern part. It is not abundant in the caves of southern Indiana, but individuals are seen not infrequently.

Habits.—This bat lives well in captivity, and will eat any kind of meat. It goes to a dish for food or picks it up from the floor more readily than any of the smaller species. Its large teeth and powerful jaws would seem to fit it for a carnivorous diet, but there is no evidence that it feeds on anything except insects.

The large brown bat is, perhaps, less truly a cave dweller than the species of *Myotis* found in this region. Among some thousands of the latter which the writer has observed in Indiana and Kentucky caves, only ten of this species were found. It is frequently seen flying in summer and the figures above, probably do not represent the correct proportion of the species in our fauna. All of the ten individuals collected were near the entrances of the cave where daylight reaches. It would seem, therefore, that many individuals migrate in winter. In common with other bats, they live in trees and buildings in summer and resort to caves rarely, if at all. Witmer Stone says of it: "About Philadelphia this is our commonest species. The large brown bat is always distinguished on account of its size, which, in the uncertain twilight, is often exaggerated. * * * It is seen late in autumn and on mild evenings in midwinter, and not infrequently enters houses during the latter season."

Genus LASIURUS Gray.

Lasiurus Gray, Zoological Miscellany, No. 1, p. 38, 1831.

Dental formula.—I, $\frac{1-1}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{2-2}{2-2}$; M, $\frac{3-3}{3-3}$ = 32.

Generic characters.—Size medium or large; ear and tragus very short, blunt and broad, the latter bent forward, the former furred over most of its outer surface; interfemoral membrane densely furred over all its upper surface. The skull is broad, short and deep, the rostrum being broader than long. The single upper incisor distinguishes the skulls of this genus from any other known

to occur within the State; the genus *Nycticeius*, of probable occurrence, has but one incisor, but it has one less premolar than *Lasiurus*. Externally, the thickly furred interfemoral membrane is the best distinguishing character.

The genus is represented by about twelve species, and is found in both Americas and west to Hawaii. Two species are found in Indiana. They may be distinguished by the following characters:

Size large; forearm 50 mm. (2 in.) or more; color brown, overlaid with white. *cinereus.*

Size smaller, forearm not over 42 mm. (1 11/16 in.); color distinctly red, with white tipped hairs. *borealis.*

LASIURUS BOREALIS (Müller).

RED BAT.

Vespertilio borealis Müller, Natursystem, Suppl., p. 21, 1776.

Atalapha noveboracensis H. Allen, Monog. Bats, N. Am., p. 142. Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 134, 1894.

Lasiurus borealis Miller, N. Am. Fauna, No. 13, p. 105, 1897.

Diagnostic characters.—Color bright reddish, overlaid with gray tipped hairs; interfemoral membrane densely furred on dorsal side.

Description.—The hair is dark chocolate brown at the base with a broad band of light yellowish following. Next comes a rather narrow band of the characteristic color which is a sort of chestnut or rufous red. Most of the hairs on the back are minutely tipped with whitish, which gives the coat a frosted appearance. The red is paler on the head and belly. Breast the same color as the back. Hairs of face yellowish, without the white tips, as are those of the belly and interfemoral membrane. There is whitish patch in front of the shoulder.

The ears (fig. 25) are very short, not reaching to the nostril when laid forward. The tips are very broadly rounded; dorsal surface heavily, and inner surface scantily furred. The tragus is short, very broad and bent forward, the anterior edge concave; the posterior edge convex, with a shoulder which sometimes is so prominent as to give the dried specimens the appearance of having a bifid tip. The membranes are rather thin and of a dark chocolate brown color. The fingers and forearm are light reddish brown. Hair extending on the wing membranes for about half an inch and covering the entire dorsal surface of the interfemoral membrane and feet; wing membrane densely furred on the under side along the forearm and base of the fifth finger.

Measurements.—Three specimens from Bloomington average: Total length, 104.3 mm. (4 3/16 in.); tail, 53 mm. (2 2/16 in.); hind foot, 7.3 mm. (5/16 in.); forearm, 41 mm. (1 11/16 in.); tibia, 20 mm. (12/16 in.); ear (from meatus), 11 mm. (7/16 in.).

Skull and teeth.—The skull (fig. 32) is short and heavy. The braincase is high, but slopes evenly to the muzzle; zygomatic arches

a b

FIG. 32.—Skull of *Lasiurus borealis*: a, lateral view; b, dorsal view. After Miller, N. Am. Fauna No. 13, Bureau of the Biol. Sur., U. S. Dept. of Agri.

prominent; palate broad; rostral region with a median depression. The teeth are large, the molars having very large grinding surfaces and the canines being thick and strong. The skull is one of the most easily recognized of our bats. Measurements of a skull from Winona Lake: Greatest length, 14 mm. (13/16 in.); length of palate, 6 mm. (4/16 in.); maxillary tooth row, 5 mm. (3/16 in.); greatest breadth of braincase, 8 mm. (5/16 in.); depth of braincase over audital bulla, 8 mm. (5/16 in.).

Range.—From Florida and Texas to the colder parts of British America. In Indiana it is a common bat throughout the State, although not taken as often as some of the other species because it does not frequent caves. It is recorded from Winona Lake, Wabash, Carroll, Vigo and Noble counties, and from Mitchell, Bicknell, Richmond, Denver and Bloomington; also from Chicago, Illinois.

Habits.—The red bat is an inhabitant of the forest, where it lives in hollow trees and among the leaves and branches. Stone states that they congregate in caves in immense numbers, and Merriam also speaks of them entering caves. The writer has had extensive acquaintance with the cave fauna of Indiana and Kentucky, but has never met with this species living in the caves. Dr. A. M. Banta, who has studied the cave fauna of this region extensively, has had the same experience.

However, there is evidence that these bats once frequented caves. In a large chamber of Shawnee Cave at Mitchell, more than

two hundred skulls of the red bat were found among the masses of fallen stone that cover the floor. A few were also found in Upper Spring Cave at Mitchell. In the same chamber, only about twenty skulls were found of the three species which now congregate there by the hundred. The red bat was sometimes seen flying about in this vicinity in the early twilight of the summer evenings, and it is quite common at Bloomington. Its absence from the caves can not be attributed to its absence from the region. The facts indicate that the habits of the species have been changing and that it has abandoned the cave dwelling habit (at least in this region) in recent times.

This is one of the species of bats said to have a seasonal migration. It has never been found in northern latitudes in winter, and has been taken in southern localities at that season, from which it is absent in summer.

The females of this species have two pairs of teats, whereas most bats have but a single pair. In correlation with this structural peculiarity, they bear a larger number of young than most bats. The most frequent number is, perhaps, three. Two are quite frequent and there are two instances on record of females containing four embryos.

A female dissected at Bloomington contained three embryos about two millimeters in length. The young are probably born about the middle of June. They are darker in color than the adults.

Godman relates an incident which shows the maternal instinct to be strong in these animals. "In June, 1823, the son of Mr. Gillespie, keeper of the city square, caught a young red bat which he took home with him. Three hours afterward, in the evening, as he was conveying it to the museum in his hand, while passing near the place where it was caught, the mother made her appearance, followed the boy for two squares, flying around him, and finally alighted on his breast, such was her anxiety to save her offspring. Both were brought to the Museum, the young one firmly adhering to its mother's tail."

Coues and Yarrow state that this species mates in the air while flying, but this statement needs confirmation, as all other species of bats whose mating habits are known mate while at rest.

LASIURUS CINEREUS (Beauvois).

HOARY BAT.

Vespertilio cinereus Beauvois, Catalog Peale's Museum, p. 14, 1796.

Atalapha cinerea Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 135, 1894.

Lasiurus cinereus Miller, N. Am. Fauna, No. 13, p. 112, 1897.

Diagnostic characters.—The largest bat found in Indiana; length over five inches; forearm two inches, color grizzled gray; interfemoral membrane densely furred above.

Description.—The arrangement of the color bands of the hair is like that of *L. borealis*. However, the band next to the hoary tips is dark chocolate, instead of red, and the white tips are longer and more numerous. On the head, the white tips are shorter and the next band is yellowish brown. On the belly it is very dark and the white tips are mostly absent.

The ears are similar in form to those of the red bat. The inner surface is thickly covered with short hairs except at the edge. The tragus is also quite hairy on the outer side. The tragus is rather more slender in proportion to its height than in *L. borealis*. The membranes are similar to those of the preceding species and are furred in the same way.

Measurements.—A single adult female from Bloomington measured as follows: Total length, 130 mm. (5 3/16 in.); tail, 54 mm. (2 2/16 in.); hind foot, 11 mm. (7/16 in.); forearm, 53 mm. (2 2/16 in.); tibia, 23 mm. (15/16 in.); ear (from meatus), 17 mm. (11/16 in.).

Skull and teeth.—The skull (fig. 33) and teeth resemble those of *L. borealis* in form, but are noticeably larger. Miller gives the following measurements for the skull of an adult female from Minnesota: Greatest length, 17 mm. (11/16 in.); zygomatic breadth, 12 mm. (8/16 in.); upper tooth row, 9 mm. (5/16 in.).

Range.—Found throughout North America, but probably not occurring in the Southern States in summer. Miller states that the species does not breed south of the boreal zone. However, a female with two half-grown young were taken in this State at Bloomington in June, and C. F. Fite has taken specimens at Denver, Miami County, on June 20 and 31. Other Indiana records are: Lake, White, Franklin, Lawrence, Monroe, Jefferson, Wayne and Wells counties.

Habits.—Like *Lasiurus borealis*, the present species is chiefly an inhabitant of the forest, and migrates southward in winter. It has never been reported as living in the caves, but two skulls were found in the Shawnee Cave at Mitchell, along with those of the red bat previously mentioned.

Little is known of the peculiarities of its breeding or feeding habits. In southern Indiana the young are apparently born early in June. Dr. A. M. Banta took a female with two young in June;

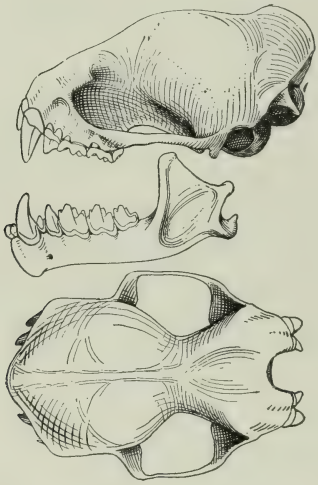


FIG. 33.—Skull of *Lasiurus cinereus*. After Miller, N. Amer. Fauna No. 13. Bureau of the Biol Survey, U. S. Dept. of Agri.

they are preserved in the collections of Indiana University. The young were still clinging to the mother, but are two-thirds grown. They measure 110 mm. in total length; forearm, 45 mm. The family were chased out of a tree by a robin and fell to the ground in front of the zoological laboratories of Indiana University.

This species does not fly until late in the evening, when it is not easily distinguished, and this fact doubtless accounts for the small number of records. It can be recognized by its large size, swift flight and pointed, hawk-like wings.

APPENDIX.

PEROMYSCUS NUTTALLI (Harlan).

GOLDEN MOUSE.

Arvicola nuttalli Harlan, Month. Amer. Journ. Geol. and Nat. Sci., Phil., p. 446, 1832.

Hesperomys nuttalli Baird, Mam. N. Amer., p. 467, 1857.

Calomys aureolus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 139, 1894.

Peromyscus nuttalli Bangs, Proc. Bost. Soc. Nat. Hist., Vol. 28, p. 197, 1898.

Osgood, N. Am. Fauna No. 28, p. 224, 1909.

Diagnostic characters and description.—Size of *P. leucopus*, but both young and adults are of a bright golden brown color above and the under parts are yellowish instead of white. In addition to these general color differences, this mouse is distinguished from *P. leucopus* in having no distinct line of demarcation between the color of the dorsal and ventral surfaces and in having the color of back extending down the limbs to the feet. The ears are also smaller, but there is no very striking difference in the skulls of the two species.

Range.—This species was first described from Norfolk, Virginia. Its range extends along the Atlantic coast from Chesapeake Bay to Florida and in the west to Missouri. It has never been recorded from Indiana and certainly is not common in any part of the State. However, it is not improbable that it will be found in the southwest portion as it occurs in Illinois.

Habits.—Kennicott, who collected the species at several points in southern Illinois, says that it is an inhabitant of the forest, although it is also found among the hazel thickets at the edge of the prairie. He states that it builds its nest in the branches of small trees and the tops of hazel bushes. The nests resemble those of birds, but are roofed over and have a small opening on the side. It probably does not burrow, though its nest has been found under a log, where it was made of fine bark and fibres and was placed on top of the ground with no underground burrow leading to it. It is strictly nocturnal in habit and its food consists of various kinds of seeds and nuts.

In the east it seems to frequent low ground and has been found to be abundant in the Dismal Swamp.

Genus REITHRODONTOMYS Giglioli.

Reithrodontomys Giglioli, Richerche intorno alla distrib. geogr. gener., p. 60, 1873.

The mice of this genus resemble the house mouse and white-footed mice in form, but are generally a little smaller. They can always be distinguished from the other slender, longtailed mice by the grooves in the upper incisors. In this respect they resemble *Synaptomys,* but they differ from the species of that genus in having slender bodies and long tails.

REITHRODONTOMYS LECONTII (Audubon and Bachman).

HARVEST MOUSE.

Reithrodontomys lecontii Audubon and Bachman, Journ. Acad. Nat. Sci. Phil., Vol. 8, pt. 2, p. 307, 1842.

Ochetodon humilis Evermann and Butler, Proc. Ind. Acad. Nat. Sci. for 1893, p. 139, 1894.

Description and range.—Color russet brown above, somewhat darker on the head and middle of the back; beneath grayish white; tail dusky above and whitish beneath. The ears are shorter than in the white-footed mice and the incisor teeth are grooved. The species is smaller than any other mouse in the eastern United States.

There is no record of the harvest mouse from Indiana, but species of the genus occur in West Virginia and others in Kansas and Nebraska. It is, therefore, possible that the species may be found in this State. It is said to live in old fields overgrown with tall grass and trees.

Genus ORYZOMYS Baird.

Oryzomys Baird, Mamm. N. Amer., p. 58, 1857.

Form similar to that of the house rat, but size smaller; molar teeth with tubercles in two rows; incisor teeth orange colored and without grooves; skull with distinct ridges over the orbits; tail long, scantily haired; belly grayish.

ORYZOMYS PALUSTRIS (Harlan).

RICEFIELD MOUSE.

Mus palustris Harlan, Amer. Journ. Sci. and Arts, Vol. 31, p. 386, 1837.

Calomys palustris Evermann and Butler, Proc. Indiana Acad. Sci. for 1893, p. 139, 1894.

Description and range.—The generic characters given above distinguish this mouse from any other likely to occur in our State.

The species was described from New Jersey and extends south along the Atlantic coast, being replaced in Florida and Texas by closely related forms. According to Evermann and Butler the species was recorded from Hamilton County, Ohio, by Langdon, in 1876. I have not been able to verify this record.

Mr. E. J. Chansler, of Bicknell, has written me as follows: "There is a kind of water rat found about ponds and streams. It is perhaps smaller than the house rat, has short front legs and long hind ones. The hind feet look to be somewhat webbed. Color light gray with dark reflections. Our boys caught some last winter while trapping for mink and muskrat along Flat Creek. They have usually been found among water lilies or about drift along Flat Creek."

Mr. Chansler does not attempt to identify this animal farther than to call it a "water rat," but the description he has given applies fairly well to the rice-field mouse. I consider him too good a naturalist to confuse young muskrats or house rats with this animal, and his statement that they have been taken in winter would also indicate that they were not young animals. In the absence of specimens I can not give a positive record for the species, and indeed there are no known facts concerning its distribution, other than those given above, which would lead us to expect it in the State. Mr. Chansler states that none of the rats have been seen for several years and he thinks they may have disappeared since the draining of Montour's and other ponds.

Genus NEOTOMA Say and Ord.

Neotoma Say and Ord, Journ. Acad. Nat. Sci. Phil., Vol. 4, pt 2, p. 345, 1825.

The rats of this genus are generally about the size of the house rat, but they have tails less scaly, the fur is softer and denser, the eyes and ears are large and the molar teeth have the enamel folded into loops and triangles much like those of the voles (*Microtus*).

NEOTOMA PENNSYLVANICA Stone.

ALLEGHENY WOOD RAT.

Neotoma pennsylvanica Stone, Proc. Acad. Nat. Sci. Phil., p. 16, 1893.

Neotoma floridana Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 139, 1894.

Description.—Size of the house rat; eyes and ears large; tail thickly covered with long, soft hairs. The color is slaty black

with a sprinkling of yellowish brown, which is brightest on the sides; belly pure white; tail the color of the back above and white below. The hairs are long and dense enough to obscure the scales which are so prominent on the tail of a house rat and the fur is everywhere softer and denser than in the house rat.

Range and habits.—The Allegheny wood rat is found in the mountains of southern New York, Pennsylvania and the Virginias. The species has also been found in Mammoth Cave, Kentucky. It is an inhabitant of caves and limestone hills and ledges. There is much territory suited for its habitation in southern Indiana, and it could easily reach this region from central Kentucky. Indeed it is rumored that these rats lived in Wyandotte Cave before the cats which now inhabit the cave, exterminated them. I have not been able to confirm the rumor and know of no record from the State. The occurrence of the species in Indiana is not improbable, however.

In Mammoth Cave they live at some distance from the entrance and hide away in the inaccessible clefts. Although they probably never see daylight their eyes are in no way degenerate. In Pennsylvania Mr. Rhoads has found them barricading the clefts in which they live with the bones of animals and other debris. In the Virginia caves they are said to build globular nests as large as a bushel basket on the cave floor.

Genus Evotomys Coues.

Evotomys Coues, Proc. Acad. Nat. Sci. Phila., 1874, p. 186.

Dental Formula.—I, $\frac{1-1}{1-1}$; C, $\frac{0-0}{0-0}$; Pm, $\frac{0-0}{0-0}$; M, $\frac{3-3}{3-3}=16$.

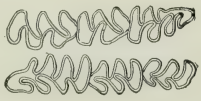


Fig. 34.—Enamel pattern of molar teeth of Evotomys. After Miller, N. Am. Fauna No. 12, Bureau of the Biol. Sur., U. S. Dept. of Agri.

Generic characters.—Size and proportions, about as in *Microtus;* color of back reddish; ears somewhat larger than in *Microtus;* upper incisors without grooves; molars rooted in adult, the crowns narrow, with the angles of the enamel rounded (fig. 34).

EVOTOMYS GAPPERI RHOADSI Stone.

REDBACKED MOUSE.

Evotomys gapperi rhoadsi Stone, Am. Naturalist, Vol. 27, p. 55, 1893. Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 127, 1894.

Description.—Color bright reddish chestnut on the back, this color being somewhat overlaid with longer black hairs; sides yellowish; belly light gray, often with a tinge of yellowish; skull (fig. 35) short and rounded.

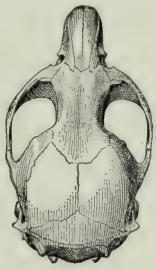


FIG. 35.—Skull of *Evotomys*. After Miller, N. Am. Fauna No. 12, Bureau of the Biol. Sur., U. S. Dept. of Agri.

Distribution and habits.—The limits of this subspecies are not known, but it, or closely related forms, occur in the woods and bogs from Quebec to the Carolinas. Evermann and Butler included it, with an interrogation, in their list under the name of *Evotomys rutilus gapperi*. They mention a specimen from Montmorenci in the collection of C. L. Reynolds, "which seems to belong to this species." I have been unable to obtain any other record from the State, and do not consider this one sufficiently well established to repeat, except in the appendix.

Rhoads states that this form inhabits the cold bogs in New Jersey. This is also true of Stone's lemming, which, however, we find in the grassy uplands in Indiana and the occurrence of the red-backed mouse in this State is by no means an impossibility. It should be looked for especially in the sphagnum bogs and tamarack swamps of the northern half, although it might also be found in other situations.

LEPUS AMERICANUS PHAEONOTUS Allen.

MINNESOTA VARYING HARE.

Lepus americanus phaeonotus Allen, Bull. Amer. Mus. Nat. Hist., Vol. 12, p. 11, 1899.

Description.—Much larger than the cottontail, with longer feet and ears. In summer the color is brighter brown on the back than in the common rabbit and the ears are tipped with blackish; in winter the color becomes clear white.

Distribution and habits.—According to Mr. Hartley Jackson, this hare "is not uncommon in most sections of northern Wisconsin." Kennicott records the killing of one (under the name of *L. americanus*) in 1824 on the present site of Chicago.

I have been led to include the species in this doubtful list principally upon the statement of Mr. I. N. Lamb, now of Richmond, who was familiar with the Kankakee Valley from 1870 to 1875. He speaks of large rabbits which he says "resemble the western jack rabbit, but is not so large; really they look more like the Wisconsin rabbit." It is very probable that a few varying hares may have occurred in all parts of northern Indiana in the early day, but their habits are very retiring and they would not readily attract notice. It is not improbable that the animal which Messrs. Evermann and Butler have recorded as a jack rabbit was really a varying hare.

It is hardly probable that any representatives of the species are living in the State at the present time. It is impossible to say, in the absence of any specimens, whether the form from this region is subspecies *phaeonotus* or subspecies *virginianus*, but the former seems more probable.

LEPUS CAMPESTRIS Bachman.

JACK RABBIT.

Lepus campestris Bachman, Journ. Acad. Nat. Sci. Phil., Vol. 7, p. 349, 1837.

Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 125. 1894.

Diagnostic characters.—Distinguished from other rabbits found east of the Mississippi by its large size, the total length being about 24 inches.

Description.—Color yellowish gray, with some brown hairs intermingled; underparts white; tail also white, with no black border. In winter, in the northern part of its range, it becomes pure

white all over. Ears very long (4½ inches from crown), tipped with blackish; inner surface white excepting a band which is the same color as the back; fur dense and soft.

Range.—From Saskatchewan to southern Kansas, west to the Sierra Nevada and possibly east to Indiana. Evermann and Butler included it in their list of Indiana mammals, saying: "Mr. Chas. L. Reynolds [a taxidermist of Frankfort] informs me that he mounted one that was taken near Chauncey, in the summer of 1888. The specimen is now [1893] in the possession of Mr. Max Spring, a stationer of Lafayette. In the winter of 1876-77, I was told that an unusual rabbit was caught near Prince William in Carroll County."

From recent correspondence with Dr. Evermann I learn that the record was made solely on Mr. Reynolds' statement, and Dr. Evermann himself has some doubts as to the correctness of the identification. I am unable to find the slightest evidence, other than this record, that the species has ever occurred east of the Mississippi, or indeed within two or three hundred miles of the Mississippi. Therefore I can only believe that there was some mistake regarding this Chauncey specimen. It could possibly have been captured and brought east by some one as a pet, or it might have been a varying hare, or more probably still, a Belgian hare.

Skull and teeth.—Skull large, nearly four inches in greatest length, broad and with the dorsal profile strongly arched; post-orbital processes free at either end. Upper incisors with a rather deep groove on the front.

Measurements.—From Baird I copy the following: Total length, 23½ in.; tail, 3½ in.; hind foot, 5½ in.; ear from crown, 4½ in.

Habits.—The jack rabbit is one of the swiftest animals that moves on four feet, at least for moderate distances. It is probable that a coyote, grayhound or antelope can all outrun these rabbits in a course several miles in length, but none are its equal in dodging and hence even the swift grayhound and coyote seldom catch them single handed. The extraordinarily long legs are special adaptations for speed, while the still more disproportionate ears are aids to the sense of hearing, which is very acute.

The nest is said to be simpler than that of the cottontails, being usually a mere mat of grass, covered slightly with fur. The young are from one to six in number and are born with the eyes open. From one to three litters are produced annually.

In some parts of the West these rabbits have been quite destructive to orchards or crops. However, the jack rabbits of California, where the greatest amount of destruction has been done, belong to another group which is characterized by their partially black tails.

PUTORIUS ALLEGHENIENSIS Rhoads.

ALLEGHENY WEASEL.

Putorius allegheniensis Rhoads, Proc. Acad. Nat. Sci. Phil., p. 751, 1901.

Description.—Size small and tail not over one inch in length; color in summer walnut brown above and pure white below, the two colors being abruptly separated. The measurements of the type specimen, as given by Rhoads, are the following: Total length, 199 mm. (8 in.); tail, 19 mm. (¾ in.); hind foot, 20 mm. (4/5 in.).

Range.—This species was discovered in western Pennsylvania less than ten years ago. One specimen was taken along the Ohio River below Pittsburg and several others in the western part of the State. More recently it has been recorded from Oberlin, Ohio, and Jackson includes it in his list of mammals of Wisconsin. I have no evidence of its occurrence in Indiana but the above records show that it may be expected in any part of the State as it might easily be carried down the Ohio from the vicinity of Pittsburg while its northern distribution renders its occurrence in northern Indiana very probable. It can be easily distinguished by the very short tail.

MUSTELA AMERICANA Turton.

PINE MARTEN; AMERICAN SABLE.

[*Mustela*] *americana* Turton, Linnaeus, System of Nature, Vol. 1, p. 60, 1806.

Description.—Size considerably larger than the mink to which it bears some resemblance; tail somewhat bushy; color light, rich brown on the back with light spots on the throat; ears high and pointed; total length about 24 inches.

Range and habits.—The marten was once common in the forests of eastern North America as far south as Pennsylvania and northern Illinois. I have no direct evidence that it was ever found in Indiana, but its range usually extended as far south at least, as that of its near relative, the fisher. It is known to occur in Wisconsin and there is a skeleton in the Chicago Academy of Science said to have been taken in Illinois many years ago. Rhoads says that it prefers deciduous, hardwood forests in Pennsylvania and this would

make its occurrence in Indiana in former times all the more probable.

Its habits are much like those of the fisher, but it lives in the tree-tops to an even greater extent. It is very shy and never stays in settled regions nor molests domestic animals. It produces from six to eight young each year and, having few enemies, holds its own fairly well in the unsettled regions of Canada. Macfarlane states that the Hudson's Bay Company sold more than 78,000 skins as the result of a single year's catch no longer ago than 1902.

Genus Parascalops True.

Parascalops True, Proc. U. S. Nat. Mus., Vol. 17, p. 242, 1894.

Dental formula.—I, $\frac{3-3}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{4-4}{4-4}$; M, $\frac{3-3}{3-3} = 44$.

Generic characters.—External form much the same as in the common moles, *Scalops*, excepting the tail, which is short, blunt and densely haired; the size is somewhat less, and the head and feet are less broad. The teeth are more numerous and the dental formula is the same as that of the star-nosed mole.

PARASCALOPS BREWERI (Bachman).

THE BREWER MOLE; HAIRY-TAILED MOLE.

Scalops breweri Bachman, Bost. Journ. Nat. Hist., Vol. 4, p. 32, 1842.

Scapanus americanus Evermann and Butler, Proc. Ind. Acad. Sci. for 1893, p. 139, 1894.

Description.—The Brewer mole bears a general resemblance to the common mole, but may be distinguished from it by the number of teeth and the hairy, club-shaped tail. This organ is somewhat constricted at the base as it is in the star-nosed mole, but it is short (1¼ in.) and bluntly rounded at the tip. The fur usually has more of a brownish tinge than in the common mole. The skull and teeth are similar to those of the common mole but somewhat more slender.

Range and habits.—This mole is limited to eastern North America from the St. Lawrence River to North Carolina and from the Atlantic at least as far west as central Ohio. There are two specimens in the Indiana University collection, correctly identified, cataloged and labeled as coming from Bloomington, Indiana. I do not place much credence in these labels and am not willing to record the species as occurring in the State on the basis of these specimens. But its occurrence is not beyond the range of probability. The species has been taken in Ohio about 60 miles from Cin-

cinnati. Very few moles have been collected in Indiana and the species might be easily overlooked as its appearance does not differ in any striking way from that of the common mole.

The habits of this species are much like those of the other moles. It is said to burrow deeper than the common mole but, like it, prefers the higher ground and is not partial to swamps as is the star-nosed species.

Genus Nycticeius Rafinesque.

Nycticieus Rafinesque, Journ. de Physique, Vol. 88, p. 417, 1819.

Dental formula.—I, $\frac{1-1}{3-3}$; C, $\frac{1-1}{1-1}$; Pm, $\frac{1-1}{2-2}$; M, $\frac{3-3}{3-3} = 30$.

Generic characters.—Size, rather small; ears, small and narrowly rounded at the tip; tragus, short, broad and blunt and much

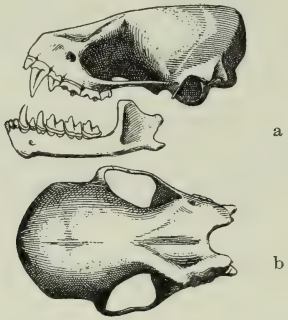


Fig. 36.—Skull of *Nycticeius humeralis*: a, lateral view; b, dorsal view. After Miller, N. Am. Fauna No. 13, Bureau of the Biol. Sur., U. S. Dept. of Agri.

bent forward; membranes and ears very thick and leathery. The skull (fig. 36) is broad and low; in dorsal profile it resembles that of *Eptesicus* except that it is slightly convex at the front of the braincase; braincase more rounded than in *Eptesicus;* the skull of the latter genus also much larger.

The genus is distributed throughout the Gulf states and as far north as Pennsylvania and Kentucky, being represented by but one species; a subspecies is found in Cuba. The dark color, leathery wings and dental formula distinguish this genus.

NYCTICEIUS HUMERALIS (Rafinesque).

THE RAFINESQUE BAT; TWILIGHT BAT.

Vespertilio humeralis Rafinesque, Amer. Monthly Mag., Vol 3, p. 445, 1818.

Nycticeius humeralis Rafinesque, Journ. de Physique, Vol. 88, p. 417, 1819.

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Description.—Color dull brown, the hairs being plumbeous at the base but the basal color shades gradually into that of the tip. Under parts somewhat lighter than the back. The ears are small and very thick and leathery; wide at the base and tapering sharply near the middle of the posterior edge; tragus short, blunt, and much bent forward.

The dentition readily distinguishes this species from all other bats of this region. It has but one tooth on each side in front of the large canine (but one incisor) and but one upper premolar. In other respects the skull bears a rather close resemblance to that of the red bat. The occipital crest is less elevated, however, and the skull, on the whole, is less angular.

The present species has never been reported from Indiana. It was originally described from Kentucky, however, and is common in the southern states as far north as Tennessee and central Kentucky. In external appearance it bears a close resemblance to the two species of *Myotis* found in this region and might easily be overlooked among a large number of them. Unless its range is more definitely restricted than that of most other species of bats, it will certainly be taken in southern Indiana sooner or later.

In addition to the characters given above, it may be distinguished from all of our species except the large brown bat, by the tail extending distinctly beyond the interfemoral membrane.

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GLOSSARY.

ARBOREAL, tree dwelling.

AUDITAL BULLA, the swelling of the tympanic bone just within the meatus of the ear.

BIFID, divided into two parts.

CALCAR, the bone extending from the tarsus along the posterior edge of the interfemoral membrane of bats.

CANINES, the tearing teeth or "eye teeth" of mammals, absent in the order *Glires* and some others.

CONGENER, belonging to the same genus.

CUSP, in mammals, the projections on the crowns of the teeth.

DIMORPHIC, having two forms differing greatly in color and appearance within the same species; e.g., black and gray squirrels.

DORSAL, the back as opposed to the belly.

EAR, measurements of the ear are taken from the point where it joins the crown of the head on the inner side.

FOSSORIAL, burrowing.

HASTATE, spear shaped.

HIND FOOT, measurements of the hind foot as used in this paper are from the dorsal side of the heel joint to the tip of the longest claw. (See Fig. 1.)

INCISORS, the front teeth (see Figs. 2 and 3).

INTERORBITAL, the region between the eyes.

MAMMÆ, the teats.

MOLARS, the teeth which come into the jaw behind the region of the milk teeth.

OSTEOLOGICAL, pertaining to the skeleton.

PELAGE, the hair or fur.

PLANTIGRADE, with the entire sole of the foot, from toes to heels, applied to the ground in walking.

POSTORBITAL, behind the region of the eyes.

PREMOLARS, the teeth in the sides of the jaw between the canines and the molars; they replace the milk teeth of the jaw.

RETRACTILE, capable of being drawn back, as the claws of a cat which are not exposed when the animal is at rest.

ROSTRUM, the anterior part of the skull, made up of the nasal and part of the premaxillary and maxillary bones.

SAGITTAL CREST, a sharp ridge along the middle dorsal region of some skulls. (See Fig. 2.)

TAIL, measurements of the tail are taken from the point of its junction with the trunk, to the end of the bony part, *not to the end of the hairs.* (See Fig. 1.)

TOTAL LENGTH, measurements from the tip of the nose to the end of the tail vertebrae. (See Fig. 1.)

TRAGUS, a slender detached lobe in the ears of bats. (See Fig. 25.)

TUBERCLE, one of the cusps or prominences on the crowns of the teeth.

VENTRAL, the lower or belly side of an animal.

ZYGOMATIC ARCH, the slender arch of bone which forms the lower part of the orbit of the eye. (See Figs. 2 and 3.)

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